The Electrical World.

VOL. XXIX. NEW YORK, MARCH 27, 1897. No. 13.

PUBLISHED EVERY SATURDAY BY

THE W. J. JOHNSTON COMPANY,

253 Broadway, New York.

Established 1874. Incorporated 1889.

Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, 620 Atlantic Ave., Boston.

Western Office, 936 Monadnock Block, Chicago.

Philadelphia Office, 929 Chestnut Street.

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THE ELECTRICAL WORLD,

253 Broadway, New York.

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INFLUENCE OF HEAT ON THE MAGNETIC PROPERTIES OF STEEL.

The paper on "The Influence of Heat Treatment Upon the Magnetic Properties of Hardened Steel" presented by Dr. K. E. Guthe before the Institute on Wednesday evening last, although of purely a physical nature, is one which has considerable bearing upon the practical problems involved in the design of electrical apparatus. It is to be regretted that the scope of the paper was not made to include a study of the increase of hysteretic loss, with continued use of iron or steel subjected to cyclic changes of magnetization, inasmuch as definite determinations of the underlying causes of this phenomenon would have considerable commercial importance. The paper is one, however, which shows most tedious and laborious research, and, although it may be questioned whether the results obtained have more than a comparative value only, owing to the considerable cross-section of the rings employed, it contributes in a very clear and explicit manner much to previous knowledge of the dependence of the magnetic properties of iron and hardened steel upon the percentage of carbon present and the character of the heating to which the material has been subjected. We are not aware that any great importance has been attached to Osmond's allotropic theory to the effect that steel is composed of an intimate mixture of magnetic and unmagnetic iron, and, although it introduces conceptions which permit of explaining phenomena otherwise difficult to account for, the experiments of Dr. Guthe apparently discredit this theory, a fact clearly pointed out by Prof. Carhart in his discussion of the paper. The question of the dependence of the remanence and coercive force on the heat treatment presents great difficulties, and for this reason alone Dr. Guthe deserves much credit for the careful investigations which he has carried out.

THE UNDERGROUND TROLLEY IN NEW YORK CITY.

The State Board of Railroad Commissioners has granted permission to the Metropolitan Street Railway Company of New York City to substitute electric power for horse power on its Fourth, Sixth and Eighth Avenue lines, and by this act gives great hope for relief from the disagreeable features of the grossly inadequate facilities of street car travel existing in this city at the present time. The enormous and rapidly-increasing traffic up and down Manhattan Island has taxed to the very utmost the capacity of every existing line of transportation, and the problem of providing additional facilities to relieve the tremendous traffic is one of the most serious questions of the day. An official of the Metropolitan Street Railway Company confesses the impossibility of adding another car to the Broadway cable service, for the reason that that line has reached the ultimate limit of its capacity. No relief in this direction can, therefore, be hoped for. The company is evidently anxious to do what it can to aid in the solution of the difficult problem, and to this end proposes to expend a vast amount of money in equipping the lines above named with the underground trolley system

The result of the agitation of the business men and property owners on Eighth Avenue, below Fifty-ninth Street, is a change in the company's original plans. The underground trolley system will be built along Eighth Avenue, below Fifty-ninth Street, as well as down Sixth Avenue, in deference to the wishes of these parties.

Little conception of the magnitude of the undertaking can be given by mere words. The work involves the rebuilding of forty miles or more of road, and the company expects to make progress at the rate of about 2000 feet per day. The fact that the improvements will involve an expenditure of between six and seven millions of dollars gives an approximate idea of the vastness of the undertaking. The underground trolley system is an expensive one to install, as compared with the overhead system, but where the latter is not permissible, the only course to pursue, where surface rapid transit is needed, is to adopt the next best system. This is the situation in New York, and by the end of the Summer it is expected that the new conditions will prevail.

CHARGING FOR ELECTRICAL ENERGY.

Of the several methods of charging for electricity now in vogue in the United States, those based upon watt-hour and ampere-hour consumption with graded discounts are most extensively used. These methods of charging, perhaps primitive in their conception, recommend themselves principally on account of their simplicity, the average consumer having no difficulty in comprehending the meaning of a discount. Although his ability is not limited to this extent, his patience would undoubtedly be sorely tried, and electricity supply brought into disfavor, were he subjected to some of the methods of charging now in vogue in Europe. According to our London contemporary, *The Electrician*, there are now in use in England eleven different methods of charging for current, while still others are being considered. Nine of these were recently discussed by Mr. R. P. Wilson, in an interesting paper read before the Northern Society of Electrical Engineers. The method of discounts based upon the kilowatt-hour consumption Mr. Wilson believes to be undeserving of consideration, while Mr. Kapp's system of differential rates, based upon the relation between the time of day of consumption, and that of the maximum station load, he views with the most favor.

There can be no question that it is advisable, from the station manager's standpoint, to encourage as much as possible the use of electricity during the day. This may be accomplished to some extent by offering increased rates of discount where motors are employed. If lights and motors are used on the same premises the simplicity of motor circuits does not materially complicate conditions, so that no great objection can be raised against the fact that two independent circuits are required.

The average consumer uses electricity for power and lighting because of the advantages which it offers, and not for the pleasure it affords. He is not likely, therefore, to burn his lights or run his motor at any particular time of the day for the purpose of deriving the benefits of reduced rates offered by the central station manager, who desires to raise his load factor. It follows that schemes devised for the purpose of inducing consumers to use light at such intervals as may best suit the station load, have apparently as little merit as would-be attempts on the part of restaurant keepers to encourage a uniform food consumption by offering discounts on the bill of fare at such hours as people are not accustomed to eat. In fact, the latter proposition could undoubtedly be more easily reduced to practice.

The central station manager is running his station under the most economical conditions when the average load bears the largest ratio to the maximum load, a fact being more thoroughly realized in this country, as indicated in the increased use of storage batteries. The high load factors prevalent in central stations were undoubtedly the chief cause for retarding the introduction of storage batteries for the purpose of making a more uniform load, but the continued success with which batteries are working is sufficient evidence that the station equipment is brought to a more economical point of operation, even when the system beyond the station is obliged to meet the fluctuating demands of service. No system of charging for electricity can bring about such favorable conditions, and it is, therefore, questionable if the use of storage batteries continues to increase in direct-current supply stations, whether radical changes in the present method of charging in such stations are to be looked for.

A NEW DISCOVERY IN PHYSICS.

It has been announced that Dr. P. Zeeman of the Amsterdam University, while working at Leyden, discovered that the lines of a metallic spectrum are broadened when the source of light is in an intense magnetic field.

The experiments of Dr. Zeeman were most rigorously and accurately conducted. Both emission and absorption spectra were examined with a large Rowland grating spectroscope, and the results were marked and certain. The meaning of the fact is clear to those versed in electro-optics, and, indeed, some such broadening had been predicted by several physicists, and sought for by others. Dr. Lorentz, of Leyden, from theoretical considerations, ventured the prediction that the light at the edges of the broadened lines would be found to be polarized. This was completely verified by the experiments of Dr. Zeeman.

The discovery will probably substantiate the hypothesis that radiation is due to the motion of electric charges, whether free or associated with the vibrating molecules of the luminous body. It has seemed more and more likely, as knowledge of ether-physics has advanced, that radiation could not be excited by the motions of the inert molecules of matter, but must of necessity require their electrification. The new facts apparently demonstrate that this is true, and throw another ray of light upon the still obscure subject of the mechanism of radiation.

Of course, the principal bearing of the discovery is upon the theory of light. It is a step toward more complete knowledge of the means by which the particles of a body at high temperature disturb the adjacent ether. It contains also the germs of conclusions regarding the nature of radiating and absorbing matter which may go far towards extending our knowledge of molecular and ether-physics. There is little doubt that the solutions of the two mysteries, the nature of light and of electricity, are destined to be simultaneously attained.

This discovery is probably the most important contribution to science since Röntgen's announcement of his new form of radiation. The fascinating field of speculation opened by each advance toward knowledge of the ultimate nature of electricity and radiation, and the mechanism of the ether, contains most alluring possibilities of discovery, and every step taken in such an advance is of the utmost importance to nearly every branch of science.

The Next General Meeting of the American Institute of Electrical Engineers.

At a meeting of the Council of the American Institute of Electrical Engineers, on Wednesday, March 24, it was decided to hold the next general meeting of the Institute on July 26, at Eliot, Me., the home of the late Prof. Moses G. Farmer. This meeting will be held in commemoration of Prof. Farmer's work, commenced fifty years ago, in the line of practical applications of electricity. The following ticket for officers of the Institute has been proposed by the Council: For president, Francis B. Crocker; vice-presidents, A. E. Kennelly, C. S. Bradley, and D. C. Jackson; managers, Alexander Macfarlane, Gano S. Dunn, W. F. C. Hasson, and Herbert Laws Webb; treasurer, George A. Hamilton; secretary, Ralph W. Pope.

The Influence of Heat Treatment Upon the Magnetic Properties of Hardened Steel.

At the meeting of the American Institute of Electrical Engineers on Wednesday evening, March 24, 1897, Dr. K. E. Guthe presented a paper on "The Influence of Heat Treatment Upon the Magnetic Properties of Hardened Steel," of which the following is an abstract:

Steel and iron, when heated to high temperatures, show a decided change in their magnetic properties. The earlier investigations have shown, that in general the temporary induction in iron and steel rods increases with increase of temperature.

After steel has been heated beyond recalescence and is suddenly quenched in cold water, the mechanical hardening is accompanied by a corresponding magnetic hardening, *i. e.*, the permeability decreases and the hysteresis loss increases greatly. This influence of hardening is well known, and was first thoroughly investigated by Ewing. Very little is known about the influence of heat treatment on such hardened steel. The present work was undertaken with a view of following the annealing process step by step, and obtaining the relations between the magnetizing force, maximum induction, remanence and coercive force for each of these steps.

The rings were all of the same form, *i. e.*, hoops with an average diameter of 12.6 cm. and a thickness of only 8 mm. The diameters were measured by vernier calipers and the cross-section was found by dividing the volume, which was determined by the loss of weight in water, by the average circumference. New measurements were taken every time after the rings had been subjected to a temperature higher than 600°. They were wound with bicycle tape, and on this the primary coil. Before each experiment the insulation was carefully tested. Rowland's ballistic method was employed. Instead of the usual way of finding the constant of the galvometer by means of an earth coil, Dr. Guthe charged and discharged a standard condenser through the galvanometer (see Carhart and Patterson's 'Electrical Measurements").

The deflection due to the discharge of the condenser was taken on open circuit. This produces an error in the constant. An independent experiment showed that the value obtained is 1.50 per cent. too large. In order to eliminate the error due to the creeping up of the induction, the steps taken were as nearly as possible the same for the same ring at different stages of the treatment. The experiments at each step for each ring consisted in the determination of the hysteresis curves for a number of different magnetizing forces, the largest in every case being between 60 and 65. In the final results are given the hysteresis curves for the largest values of H only. It was thought to be of more importance to represent the curves for B_m and B_r as functions of the maximum magnetizing force. (See Fig. 4). Moreover, it was possible to show the influence of the reheating upon Houston and Kennelly's law, THE ELECTRICAL WORLD, 25, 631, 1895, *i. e.*, that for small magnetizing forces the remanence (B_r) is a linear function of the maximum induction (B_m). These two values, B_m and B_r, are plotted on Fig. 5, and these curves are of great interest, showing the range through which this law holds good in the different stages of the heating process, and what variations in the constants are produced by the tempering.

The chemical analysis of the rings gave the following results:

	Ring I. Crescent Steel.	Ring II. Basic Steel.	Ring III. Very Soft Steel.	Ring IV. Swedish Iron.
Carbon	.868%	.309%	.0755%	.144%
Silicon	.234	.025	.0155	.0624
Sulphur	trace	.059	.0645	.015
Phosphorus	.0172	.146	.124	.018
Manganese	.27	.78	.36	trace

The measurements of rings gave the following data:

	Ring I.	Ring II.	Ring III.	Ring IV.
Mean diameter.....	12.607 cm.	12.699 cm.	12.63 cm.	12.607 cm.
Volume	95.099 cm³	80.637 cm³	109.29 cm³	107.99 cm³
Cross-section	2.401 cm²	2.021 cm²	2.754 cm²	2.727 cm²

The rings were first heated in the original state and then subjected to the heat treatment. The hardened rings were then tempered by reheating to the temperatures indicated below, and then allowed to cool slowly. D, 100° for one hour; E and F, 100° for 24 hours; G, 200°; H, 300°; I, 450°; K, 800°; L (only for rings II. and III.), about 950°.

RESULTS.

A. Rings in the original state.

The hysteresis curves show strongly the influence of carbon, the area of the loops diminishing with the decreasing percentage of carbon. The mild steel shows, indeed, a curve very similar to that of wrought iron. The maximum induction, taking the rings in the order I, II, III, has the values: 13840, 15070, 15290 lines of magnetic force, while the magnetizing force was very nearly the same in all cases. The corresponding coercive forces are 8.6, 2.7 and 3.6.

B. *Rings heated to 675° and quenched.*—The rings were then introduced into furnaces, which were well heated beforehand. The heating to a dull cherry red took about eight minutes. Then the ring was withdrawn quickly and quenched in water at 5° C.

Ring I has become magnetically harder, *i. e.*, the maximum induction for the same magnetizing field has decreased, the permeability, especially for low fields, is smaller, and the coercive force increased to more than twice its original value.

The iron ring shows an increase in permeability, which may be explained by a previous mechanical hardening, when it was turned to its proper shape.

In rings II and III there is no sign of magnetic hardening, the principal influence of this treatment being the remarkable drop of the remanence, while the maximum induction remained almost unchanged. The permeability, on the other hand, decreased a little.

It is apparent that we have not passed the temperature at which low carbon steel is hardened. It is well known that the second and third point of recalescence for low carbon steel lies at a higher temperature than the corresponding point in the high carbon steel, which apparently had already been passed in the case of the high carbon steel. It is, therefore, probable, that the magnetic hardening takes place when the steel is quenched after it has been heated to the same temperature at which recalescence occurs, *i. e*, the critical temperature, at which, according to Hopkinson and others, iron loses its magnetic properties.

C. *Rings heated to a little above 900° and quenched in icewater of 5°.*—The heat treatment was the same as before, but the temperature was raised beyond the third point of recalescence of the low carbon rings.

All the steel rings show the hardening effect, the same being the smaller the less carbon the steel contained.

The high carbon ring (I) shows a decided increase in the hysteresis loss, which is much greater than the increase due to the first heating. While the first time the temperature was raised only a little beyond the point of recalescence, it was this time at least 250° higher. We draw therefrom the important conclusion that steel becomes magnetically the harder, the more the temperature is raised beyond the recalescent point. The passing of this point by only a few degrees is not sufficient for the maximum effect.

The hysteresis curves for the steel rings are given in Figs. 1, 2 and 3, the maximum induction (B_m) and remanence (B_r) as a function of the magnetizing force on Fig. 4, and B_r as a function of B_m on Fig. 5.

D. *Rings reheated to 100° for one hour.*—The corresponding curves are marked by crosses on the plates and are drawn only for the low carbon rings, the change being very small for the high carbon steel. The influence of this step becomes more apparent the less carbon the steel contains, and it consists in a lowering of B_m as well as B_r in rings II. and III., and in a slight raising of the same quantities in ring I. The coercive force in III. has become slightly larger. The low carbon steel becomes, therefore, magnetically harder when it is reheated to 100°. This result is consistent with the observations of Barus and others, mentioned above.

E. and F. *Rings heated to 100° for 24 hours.*

G. *Rings heated to 200°.*

H. *Rings reheated to 300°.*—All rings show a decided increase in permeability, the change being the smaller the less carbon the steel contains. The curve for ring III, indeed, coincides so closely with that of the hardened ring that the points corresponding to this step could be indicated only by dots in the plates. This wrought iron ring, that so far showed no sign of a change, has a larger permeability for small fields than it had before. By comparing the

curves in Fig. 4, we see a decided tendency towards an increase of the remanence for any given value of maximum induction.

The most important and rather unexpected result of this step is the sudden very large increase in the maximum induction of ring I. The number of lines of magnetic force has almost reached the value the ring had before it was heated at all. Therefore, whatever change in the chemical or physical constitution of the ring produces the change in the magnetic properties, it is largest for the high carbon ring between 200° and 300°, *i. e.*, at a temperature which corresponds to that of the blue temper of steel.

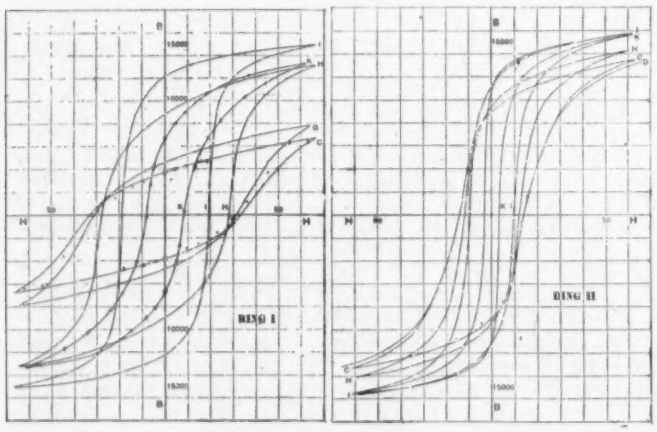
I. *Heated to* 450°.—We observe a further increase of permeability and induction for all rings. The change for ring I. is only about one-third of the one in the preceding case, while we have a comparatively large change for rings II. and III., corresponding to the large difference in B_m of ring I., observed before, and to be attributed to the same causes.

It is to be noticed that, though the magnetic flux has practically reached its maximum for the field strength used, the value of the coercive force is still quite large in comparison with the corresponding value for the rings in the original state. The remanence for ring I. is larger after this step than in any other. The substance is Crescent steel, *i. e.*, magnet steel. It is apparent that, *in order to make strong magnets, it will be advisable to reheat the quenched steel to about* 450°. The magnets could be made more than twice as strong as if simply the hardened steel is used. Though closed magnetic circuits were used, the influence of the ends of the magnets will be the same in the two cases. It is of importance that the coercive force did not decrease nearly as fast as the remanence increased.

K. *Rings annealed.*—While in the rings II. and III. the saturation point was practically the same as before, the coercive force decreased to its smallest value, this last step being the largest in the whole series for the coercive force.

In the high carbon steel and the wrought iron, we find a remarkable decrease in B_m, accompanied in ring I. by a still greater decrease of B_r, while in the iron B_r increases with respect to B_m. These changes can very plainly be observed on Fig. 5, where B_r is plotted as a function of B_m. The curve obtained for ring I. differs entirely from any of the curves taken after the ring was hardened, but it shows a great similarity to curve A taken in the original state.

L. *Reannealed.*—Both rings show the decided decrease of B_r and the different character of the curve. The one for ring III. is indicated by dots only, and coincides partly with curve C. In both cases there is a great similarity with the curves B, obtained by heating the originally annealed steel to a high temperature below the point of recalescence and suddenly quenching. It almost seems that the steel by this process has become a different substance.



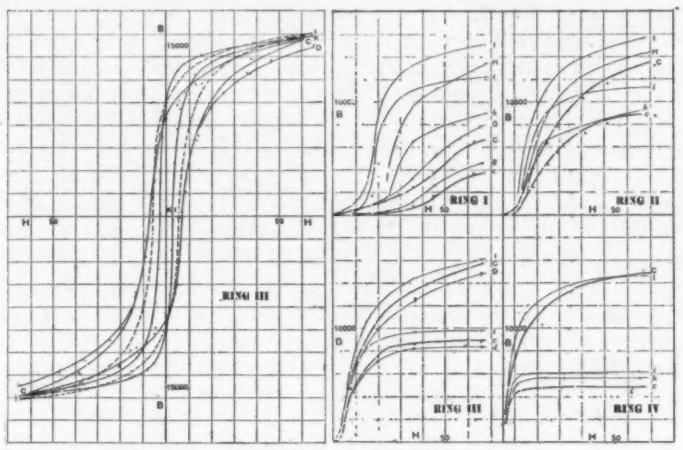
FIGS. 1 AND 2.

Steel heated to a high temperature below the point of recalescence and suddenly quenched, will very easily lose its magnetism. This seems to me of practical importance. The maximum and induction being the same, the remanence a great deal smaller than in the ordinary state, it is apparent that the hysteresis loss will be much smaller, and therefore very mild steel, as our ring III., treated in the way indicated above, is preferable to the ordinary mild steel used in transformers or other instruments, in which cyclic processes take place.

Since the hysteresis loss has been found to increase appreciably in transformers after they have been used for some time, it is of great importance to investigate whether a similar effect takes place in steel treated in the manner suggested. A series of such experiments seems to me very valuable from a practical point of view.

The results of this research may be summarized as follows:

1. The point at which steel becomes magnetically hardened by quenching, lies at different temperatures, according to the amount



FIGS. 3 AND 4.

of carbon contained. It is considerably lower in high carbon steel, than in low carbon steel, and corresponds closely to the different temperatures at which occurs recalescence of steel.

2. The higher above the point of recalescence steel is heated before being quenched, the harder it is magnetically.

3. The magnetic hardening produced by quenching is the larger, the higher the percentage of carbon.

4. Reheating has in general a softening effect upon the magnetic properties of hardened steel, *i. e.*, the permeability increases, and is accompanied by an increase of maximum induction and a decrease of the coercive force. But a hardening is noticeable in the low carbon steel after it has been reheated for a short time to 100°. The greatest change in the maximum induction takes place for high carbon steel between 200° and 300°, for low carbon steel between 300° and 450°, beyond which temperature there is hardly any change in the practical limit of saturation. All change taking place in reheating beyond 450° consists in an increase of

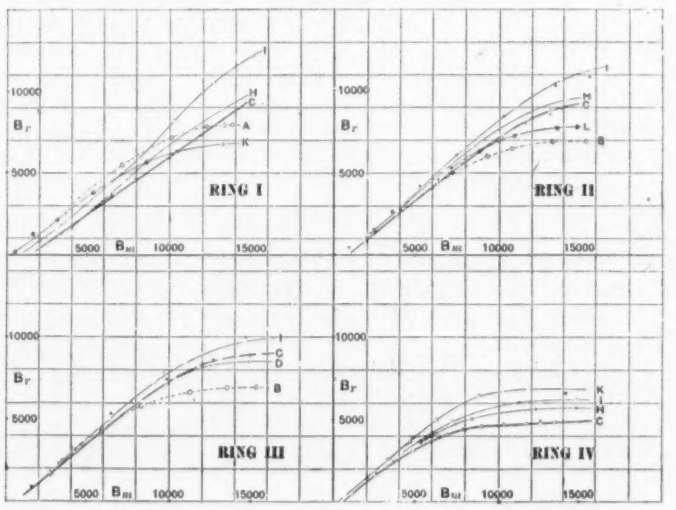


FIG. 5.

permeability for small magnetizing forces, *i. e.*, a decrease in the coercive force or hysteresis loss.

5. To produce strong magnets, the hardened steel should first be reheated to 450°.

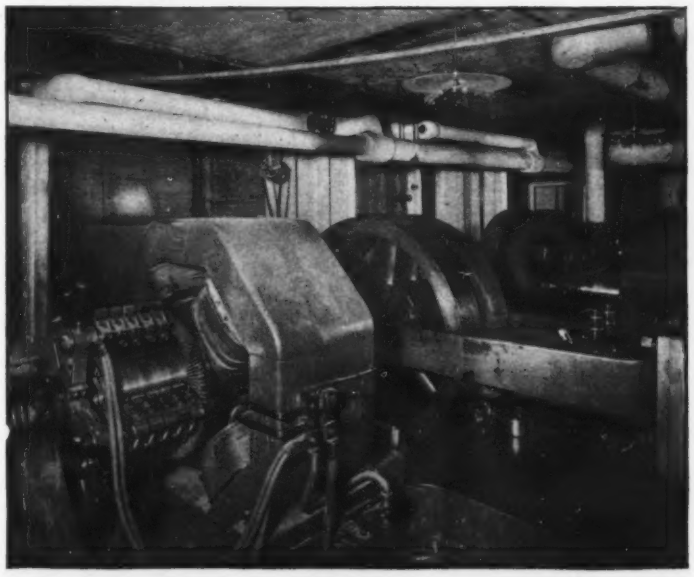
6. Heating to a high temperature below the point of recalescence and sudden quenching produces a steel with a very weak retentivity; in consequence of which the hysteresis loss in a cycle is greatly decreased. This result may also be obtained, though in a lesser degree, by annealing at a very high temperature.

Electric Plant of the St. Paul Building, New York City.

IT is almost impossible to prophesy the ultimate development of the present tendency to advance skyward in our modern office buildings. Ten to fifteen story buildings were considered extremely high some years ago, but with the advent of veritable towers, including some twenty to twenty-five floors from ground to top and the proposed addition of from five to ten floors in buildings to be constructed in the near future, we cannot help asking "Where shall we stop?"

The modern skyscraper is strictly an American institution; our European cousins know naught of them, and probably regard them with awe and wonder, questioning their safety and actual value. American investors and architects seem, however, to have fully satisfied themselves regarding both of these considerations, as is clearly demonstrated by the continual increase in the number of such structures in our large metropolitan business centres.

Probably the greatest recent development in this direction has occurred in this city where the exceedingly small business area at the lower end of Manhattan Island has necessitated concentration and increase of available floor space to meet the demands of our ever-increasing business and commercial interests. Usually where ground is the scarcest and most valuable the maximum of available floor space is most desirable. One would even be led to believe from actual practice in many instances that the rule followed in building these many-storied structures is to make the height of the building inversely proportional to the ground area upon which it stands.



ENGINE ROOM.

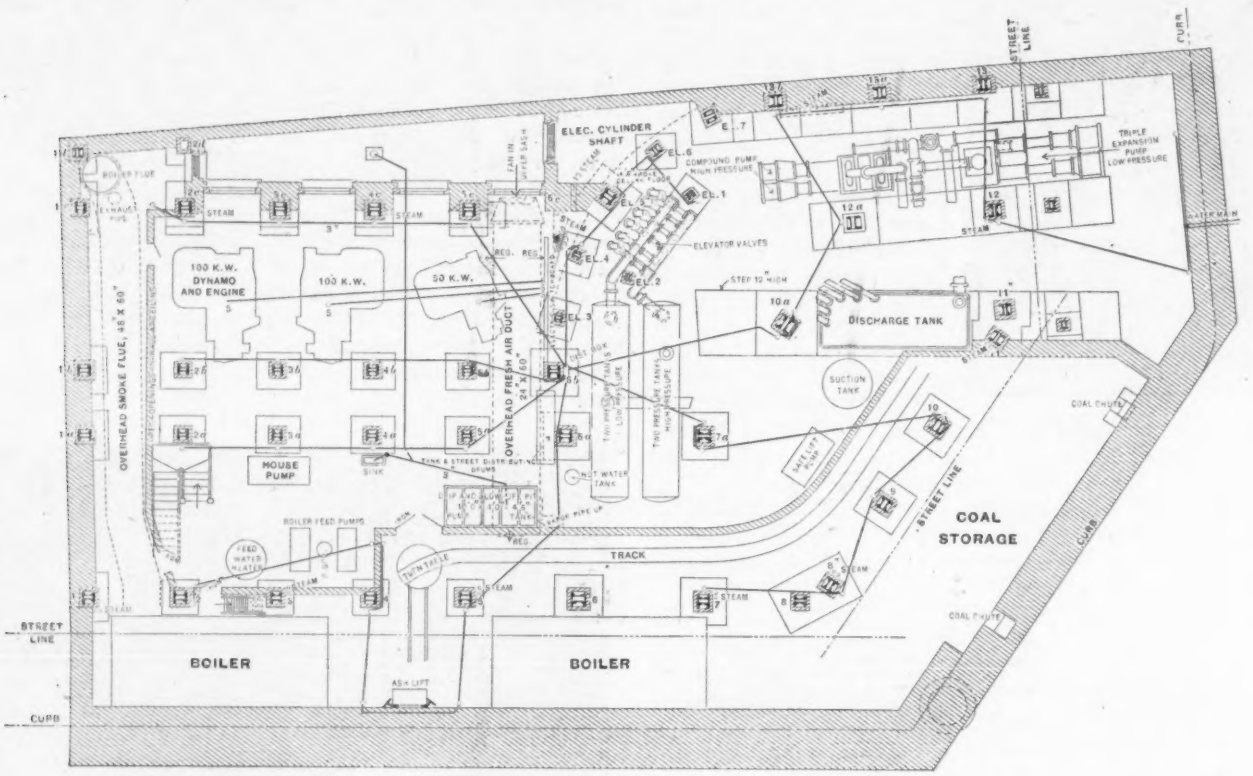
One of New York's latest productions in this direction, the new St. Paul Building, seems to most particularly carry out this rule. This immense tower of offices was built under the plans and supervision of Mr. George B. Post, the prominent New York architect, for Mr. H. O. Havemeyer. It stands on the southeast corner of Broadway and Ann Street, directly opposite St. Paul's Church, on the site formerly occupied by the old New York "Herald" building and also by Barnum's Museum. The plot is associated with many historic events and this new immense structure forms a fitting monument in commemoration of them. An observer is immediately struck with the exceedingly small foundation site from which the building towers far into the heavens, standing entirely alone above all others in the vicinity. The lot is probably one of the smallest occupied by any high-class New York office building, measuring only 60 feet on Broadway by 100 on Ann Street. The total height of the building from the ground to the top is 309 feet, while the basement and sub-basement extend 39 feet in addition to this downward to the foundation base. The building includes twenty-five floors, surmounted by a deck-house (each floor averaging a little over 12 feet) a basement and cellar. At the 18th floor the sky line of the building is broken, making the area of the floors above this somewhat smaller, and again at the 22d floor the building extends upward in the form of a tower, although of ample proportions. The ratio of available floor space to ground area is undoubtedly far in excess of any other similar structure, there being approximately 100,000 square feet of floor space available for business purposes in the building. A particularly notable feature of the building is the extremely heavy steel girder framework which is mounted on grillage beams set in cement. The floors are of arched terra cotta finished with marble tiles throughout the halls and hardwood in all offices. The exterior of the building is of Indiana limestone, being entirely exposed and amply windowed on all sides above the few lower floors.

SWITCHBOARD.

All machinery is located in the cellar. It would seem that the area of a single floor would scarcely accommodate the complete machinery of a building of this size, but the general layout is most compact, although at the same time affording ample facilities for handling and operating the various apparatus. The entire cellar is used as one large machinery room without any interior dividing walls, aside from the building line wall which separates the vault under the Broadway and Ann Street sidewalks from the main building. The machinery equipment includes engines, boilers, dynamos, a large pump service for hydraulic ele-

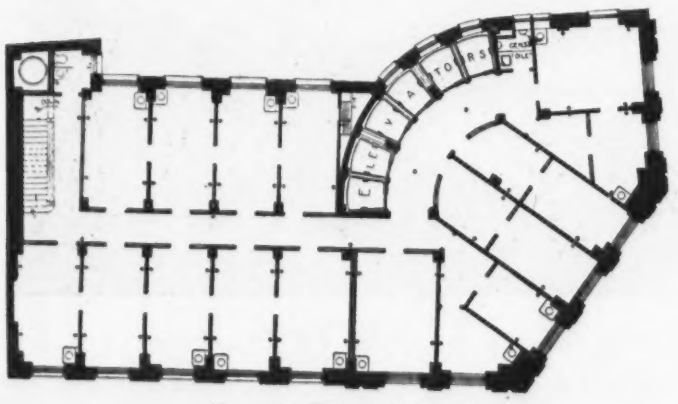
vators, water supply apparatus, etc., and a complete telephone system, both public and private. The vault under the sidewalk, which is walled off from the main cellar, access being had through fireproof iron doors, is used as a boiler room, having suitable coal storage facilities at the Broadway side. A small narrow gauge track runs from the coal storage bin through a passageway between the building line and boiler walls and coal is carried to the boilers in a small four wheeled car.

There are two Babcock & Wilcox water tube boilers which are located facing each other at the rear end of the Ann Street vault.

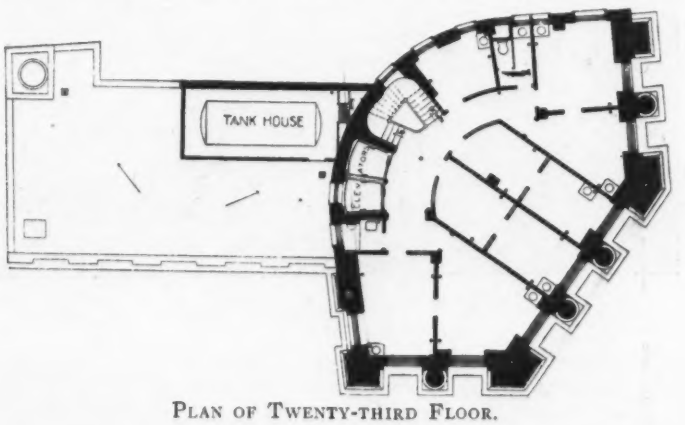


Plan of Cellar Showing Location of Machinery.

These boilers are each of about 200-hp and are equipped with two horizontal 36-inch water drums connected to 108 four-inch eighteen feet long water tubes. They are of a special type built of wrought steel tested to a tensile strength of 56,000 to 62,000 pounds per square inch. Ordinarily 110 pounds of steam pressure is carried. The boilers are tested to over 200 pounds. Each boiler is set in masonry walls, the outside walls being 17 inches thick, rear 12 inches, front 15 and bridge 24 inches. The tubes from both drums are connected to a common mud drum. The steam drums of each boiler are connected together and piped through two 8-inch globe valves, one after the other, to a 12-inch steam main, into which the boilers feed at opposite ends. This steam main is tapped between the boilers by a high pressure steam pipe 10 inches in diameter, which feeds the various engines and pumps, and also by a house-heating main through a Keily differential reducing valve, permitting the direct use of live steam for the house-heating system. A suitably valved by-pass is arranged around this reducing valve. A Ford damper regulator suitably regulates the draughts of each boiler. Two Worthington duplex steam pumps are provided for boiler feeding. They are arranged to supply feed water to the boiler from both the city supply and main return pipes and are controlled by a Keily automatic pump governor, which controls the feeding according to the boiler pressure. These pumps feed through a Berryman feed water heater, and all feed pipes are of polished brass. Each boiler is also equipped with a 1½ inch Monitor injector. The feed pipe at each boiler divides so that each steam drum is separately supplied.



Plan of Tenth Floor.



Plan of Twenty-third Floor.

The high pressure steam pipe is tapped for the various pumps and extends to the engines on the opposite side of the cellar, it being arranged by means of suitable U's in the piping to allow for contraction and expansion. The steam pipe at each engine is arranged with a T separator so as to provide dry steam. Keily condensation traps control all the water drips from live steam piping which are fed back to a common return.

The exhausts from all the engines and pumps is piped overhead to a 12-inch exhaust main which divides at the rear of the cellar, one pipe extending to the roof and exhausting into the air; the other passing to a Keily grease extractor and from thence to the feed water heater and also to the house-heating system. A 12-inch Keily back pressure valve is located in the roof exhaust. All pipes are covered with asbestos and magnesia covering.

The house-heating system consists of 460 direct steam radia-

tors, which are supplied with twelve sets of risers and returns from the main heating service pipe in the cellar which gradually tapers from 12 inches to four inches in diameter. The heating system may be supplied with either live steam through the differential reducing valve or from the exhaust, as has been described. All drips from engines, etc., are pumped to the sewer from a blow-off tank and a separate pump is also provided for pumping drips from the cellar. Worthington duplex pumps are used throughout. The pump cylinders are lagged with sectional Russia iron coverings and have polished brass trimmings.

The electric lighting plant consists of three direct-connected units placed in a row along the inner southwest wall of the cellar. These units consist of Straight-line engines, direct-connected to Eddy dynamos. There are two 160-hp engines connected to 100-kw dynamos operating at 250 r.p.m. and one 80-hp engine connected to a 50-kw dynamo operating at 275 r.p.m. The engines are of a new and improved design particularly intended for heavy and continuous service, and are provided with a sensitive fly-

from each dynamo are run to the switchboard, each wire in a separate iron armored conduit laid in the cement floor.

The switchboard is located at the head of the engines and dynamos on the south inner side of the cellar and directly under the wire shaft which extends up through the building in the rear of the elevator shafts. Four marbleized slate vertical panels form the board proper. These are held together by suitable angle irons and supported on five enameled cast iron pillars, leaving ample space behind the board. All bus bars and connections are on the back of the panels. The panel farthest to the right is used as a public telephone terminal board to which are brought all the public telephone wires from the various telephone instruments in the building, and thence to the subway cables extending to the central office of the New York Telephone Company.

The board is equipped with Weston indicating ammeters and voltmeters, differential galvanometer and ground detector, Bristol recording volt and ammeters, double-pole main dynamo switches and single pole I. T. E. main dynamo circuit-breakers and triple-

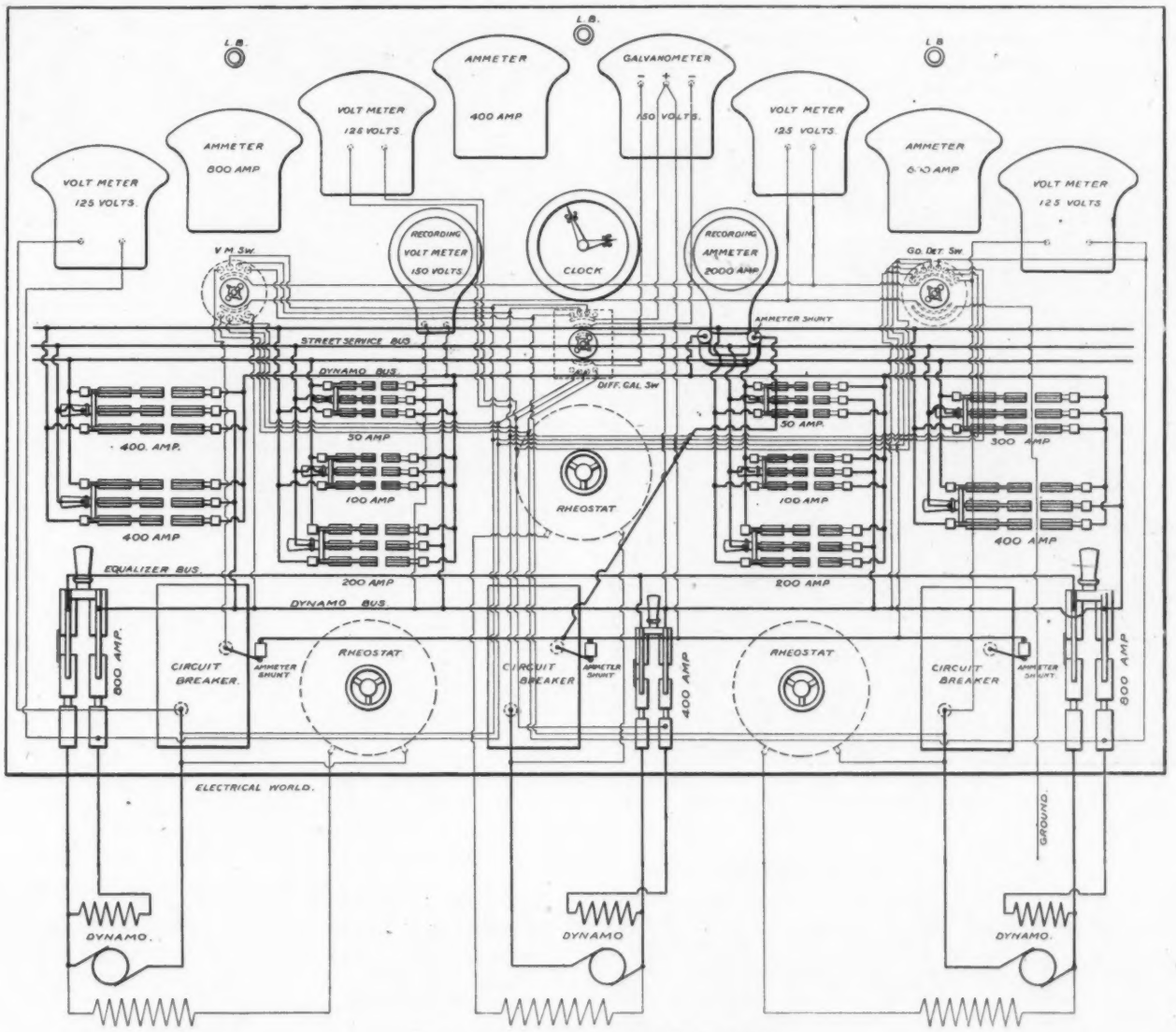


DIAGRAM OF SWITCHBOARD CONNECTIONS.

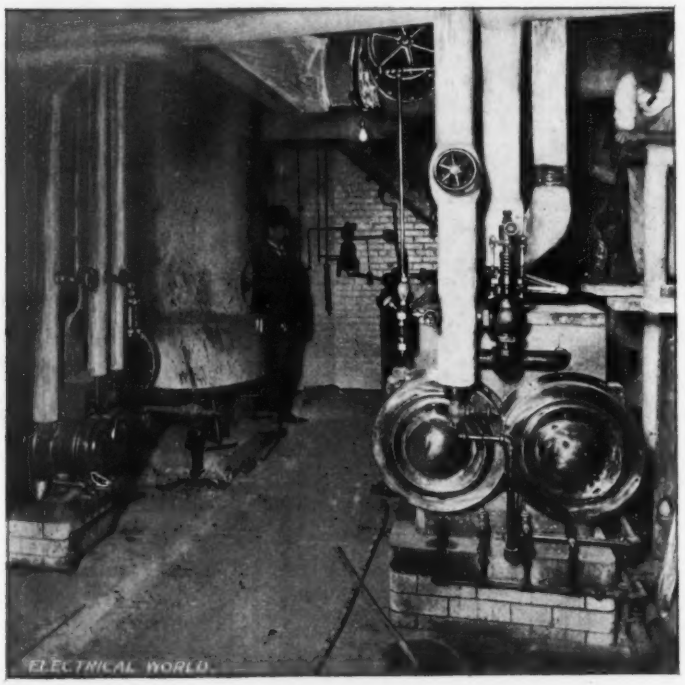
wheel governor. The dynamos have octagonal frames and four internally-directed poles, They are compound wound with a variable increase of from 2 to 15 volts, but are to operate ordinarily at 125 volts with a compounding of about 2 volts, which is all that is needed by the wiring system of the building.

The armatures are of the slotted drum type wound with copper bars. Each dynamo is provided with double terminal plugs fitted with main fuses and the equalizer wire is controlled by a switch mounted on the frame of the machine. The combined unit is mounted on a cast iron sub-base set on a solid concrete foundation pier which is mechanically insulated from the building foundation by a layer of felt—⅛ to ¼ inch thick when compressed, to prevent transmission of vibration to the building. The tops of the foundation piers are flush with the cement floor. The leads

pole double-throw single pole feeder circuit switches, Carpenter enamel rheostats and Van Nuis voltmeter and ground detector switches. Each dynamo circuit is brought to its respective main switch and circuit-breaker, all of which are arranged alternately at the bottom of the board, and connects thence to a main two-wire dynamo and equalizer bus. The equalizing wire from each machine is directly connected to the bus. Another three-wire bus on the board is connected with the Edison street service supply. The feeder switches are double-throw, triple-pole, set horizontally and located immediately above the main dynamo switches. The opposite terminal clips are connected to each respective bus, and the central contact or blades are connected to the feeders, which can thereby be connected to either the street or dynamo service. The main dynamo current supply is recorded by

the Bristol recording ammeter, which is connected in circuit with one side of the dynamo bus. The recording voltmeter is permanently connected to this bus. Each dynamo has a separate ammeter. The differential galvanometer can be connected with the bus and any of the dynamos, for which purpose a suitable switch is provided. A voltmeter is connected to each of these machines, and one voltmeter is controlled by two switches, so that it can be used as either a ground detector or can be connected to any of the machines and the bus bars.

There are between twenty-five hundred and three thousand 16-cp incandescent lamps located throughout the building. The building is wired with three wires on all feeders and mains, the neutral wire being of a capacity equivalent to both the outside wires. Each of the feeder switches controls a single-feeder circuit. There are eight feeders, supplying, respectively, the basement and cellar, the basement and first floor, all entrances, halls and stairways and other public parts of the building, the second floor, the third to the eighth floor, inclusive, the ninth to the thirteenth floor, inclusive, the fourteenth to the nineteenth floor, inclusive, and twentieth to twenty-sixth floor, inclusive. The feeders, supplying the sections above the third floor carry about 400 amperes each. Each of these feeders connects on floors midway in the various sections to a vertical three-wire main running up and down from a junction box lo-



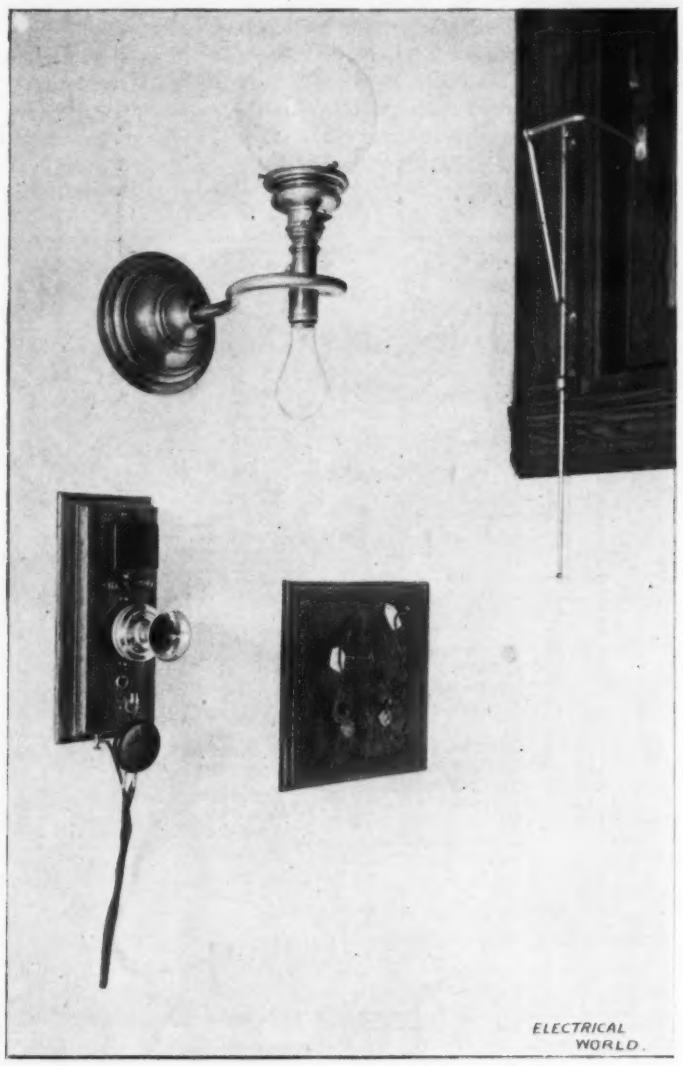
Feed Water and House Service Pumps and Feed Water Heater.

cated in the wire shaft. From this main through suitable distributing boxes, two sub-mains are tapped at each floor, each extending to a panel box on the floor. From here two-wire branch circuits extend to the various fixtures. The total drop is three volts, including feeders, mains and branches. The branch circuits carry an average of about eight 16-cp incandescent lamps. All main junction and distributing boxes are slate-lined with slate bases. The panel boxes are double slate-lined with slate baseboards and copper terminals, and a glass-covered diagram showing the exact carrying capacity and location of the various circuits from the panel terminals is placed on the inside of each door. Each branch circuit is controlled by a double-pole copper knife switch.

All lighting wires throughout the building are Habirshaw white-core, rubber-insulated, carried in either iron-armored conduit or Bergmann steel-armored conduit, the feeders and mains having a single wire in each tube, while branches have two wires in each tube. Almost all outlets are on the side walls through suitable single-piece cast-iron outlet boxes, with bored sides to fit the tubes, which are fastened in with cement.

Combination fixtures, installed by the Oxley & Enos Manufacturing Company, are used throughout the building. The fixture wires are connected with solid joints to the outlet wires. All public lighting switches are of the Perkins lock type, and Cutter double-push flush switches have been used wherever it has been necessary to control office lights.

A particularly notable feature of the electrical equipment is embodied in the very complete public and private telephone system which has been installed throughout the building. Each office has been wired, not only for a public 'phone, but is also equipped with a private telephone set connecting with a central office located in the rotunda on the ground floor, thus enabling any tenant to communicate with any other or any person on the ground floor



Office Telephone Set and Messenger Call Service.

to communicate with any tenant. There are about 375 private telephones located throughout the building.

Each office telephone set consists of a small, oblong, neatly finished oak base board, on which is mounted an Ericsson coal gram transmitter, buzzer, push button and 70 ohm watch case receiver. A double metallic circuit connects the office instrument with a drop and suitable jack plug receptacles at the switchboard. No induction coil is used, the transmitter being connected direct. The calling current is furnished by a small Crocker-Wheeler motor-generator, supplying all circuits through a common wire. In calling, the button at the wall instrument completes its respective circuit, causing the drop to fall, and closing the ringing attachment circuit at the switchboard. A separate battery is used for speaking, and is bridged over the ringing circuit with the operators' instrument, when necessary, thereby opening the calling-generator and drop branch.

The switchboard is built of quartered oak, measuring 7 feet 5 inches high, 5 feet 8 inches wide, and one foot deep. All drops are mounted on the upper section, while the jack contacts are on the lower. There are ten sets of plugs and flexible cords, so that ten connections between various sets may be made. Two operators' transmitters are provided, suspended from the top of the board by nickeled hangers. The operator is furnished with a head-listening attachment. By means of two handles in front of the board

all drops may be swung back by the operator without bending forward. It is to be noted that the equipment marks a new departure in office building telephony, and is, in fact, probably the largest plant ever installed in a single building.

The wires for both the public and private telephone system are run with all electric lighting wires through the main wire shaft. The cables for both services are supported in the shaft in suitable wooden cleats, each wire being 16 B. & S. gauge Habirshaw rubber insulation. At the various floors a separate pull box is located for each service. From the public service pull box on each floor two cables are run in iron pipe conduits to a common pull box in the hall, and then separately, each in a single iron pipe, to individual pull boxes, from which various $\frac{5}{8}$-inch iron pipes ramify to the different offices, each carrying the two wires necessary for the telephone instrument. This public service pipe system also carries the various messenger and other signal wires that may be necessary. The messenger call wires are brought to a nicely finished hardwood baseboard on the wall in each office.

The private system is practically the same as the public, excepting that the pull boxes and pipes are on the side walls. The individual pipes are also somewhat smaller, $\frac{3}{8}$ of an inch in diameter. Each floor is additionally connected with the engine room by means of a speaking-tube and whistle. A notable feature is the absence of a watchman's time detector system. It is intended to keep the building open at all times.

The elevator equipment of the building consists of six Otis hydraulic elevators, two of which stop at the ninth floor, two at the sixteenth floor, and two run to the twenty-fifth floor. These elevators are of the duplex pressure type, water being supplied from high and low pressure tanks. The high pressure tanks are supplied by a duplex compound steam pump, the low pressure tank by a triple expansion steam pump, and a duplex compound auxiliary pump is also provided. For safe lifting purposes a very high pressure pump is used and may be directly connected to one of the elevator cylinders. These elevators operate at about 600 feet per minute. The operator by means of the controlling lever adjusts the pressure on the elevator piston. They are arranged in the form of an arc very close to the Broadway entrance.

The entire electric plant of the building, including telephones, etc., was directly under the supervision and installed according to the plans of Messrs. Pattison Brothers; the electric light wiring and switchboard were put in by the New York Electric Equipment Co.; the private telephone system was installed, complete, by the Wilson-Bates Electric Co.; Hatzel & Buehler furnished the public telephone wires; Messrs. Robinson & Wallace were the builders.

Rotary Transformers.

BY J. E. WOODBRIDGE.

Now that so called "static" and "rotary" transformers are coming into such extensive use for transforming high pressure alternating currents into direct currents of any desired voltage, a description of a device without moving wire, which will alone perform the duties of both, should be of interest.

It is a well-known fact that if multiphase currents be properly led into any continuous winding such as a closed-coiled direct-current armature, a rotating magnetic field will be set up. If the connections are in the proper phase relation this rotary field is of uniform strength, and rotates uniformly, keeping time with the alternations of the current supplied.

The result on the windings is of course the same as though a set of field magnets were rotated about the armature, which is, of course, the same as though the armature were rotated in a set of field magnets. All that is needed to obtain direct currents is a commutator and set of brushes rotating in time with the field magnetism and in proper phase relation therewith.

A description of a simple experiment will illustrate this point. A toothed-core direct-current armature was taken from its bearings and overwound with iron stovepipe wire over the whole length of the armature core and to a considerable depth, the iron windings being circular after the fashion of binding wires. The fields of the machine were removed and the armature was replaced and coupled to a small synchronous alternating-current motor.

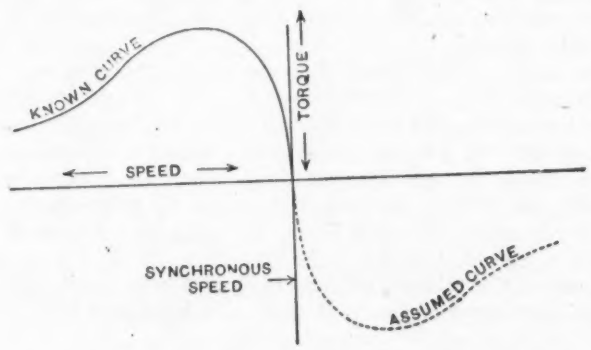
Three-phase currents were led into three collecting rings which had been mounted and connected to three equidistant points of the armature windings. When supplied with these currents and rotated by the alternating-current motor fed from the same source of supply, direct currents were drawn off from the brushes, the voltage at the direct-current end being $\sqrt{2}$ cosec. 60 degrees (about 1.6) times the voltage between the three-phase leads.

Of course the same result would have been derived had the armature remained stationary and the brushes been revolved by the synchronous motor, but the method described was simpler with the apparatus at hand.

In commercial machines of such a type the cross magnetizing action of the direct currents might be a serious factor, or the increased self induction of the coils might interfere with good commutation, but it would seem as though neither of these difficulties would be difficult to remedy.

If this principle is found commercially practicable, a machine of elegant simplicity may be made up somewhat as follows: Let the core be a gramme ring with a ratio of internal to external diameters 1 to 3, or 1 to 4, and with a ratio of axial thickness to radial breadth of cross-section about the same. Let the laminations be cylindrical after the fashion of a Brush dynamo armature, and let the radial slots overlap at the inner rim. Then the inner cylinder windings can be turned up into an annular commutator, and the radial windings on both sides of the core can be made active by covering them with a flat lid of spirally laminated iron.

The brushes might be driven by an iron armature so disposed as to catch the magnetic leakage through the commutator, but would



TORQUE CURVE OF INDUCTION MOTOR.

probably be better driven by a separate synchronous motor. In the latter case the lead of the brushes could be adjusted by simply rotating the fields of the motor.

If the shaft were mounted vertically the brushes could be held to the commutator by the simple agency of centrifugal force.

If an alternating transformation was necessary to obtain the proper voltage both windings could of course be wound on the core of the transformer described, and both transformations effected in the one machine.

Just how the apparatus would act to transform direct to alternating currents is unknown to the writer, but both theory and experiment tend to show that some extraneous source of excitation of the rotary field would be necessary.

Another point which the writer has not seen published is the ability of the induction motor to run as a dynamo. Such a machine would not be self-exciting of course, but when run in multiple with an ordinary multiphase generator the induction machine may absorb mechanical power, and give it to the lead or to the other machine, if run above synchronism.

A consideration of the torque curve of an induction machine as shown in the figure (with speeds of the rotor considered as they should be considered relatively to the speeds of the rotation of the magnetization) would lead one to believe that the torque curve is symmetrical about the zero point. A modest experiment tends to bear this out.

If induction machines will so run in multiple with separately excited generators, practically exciting their own fields by the "slip" of their rotors, large alternating-current stations might have two or three machines to act as exciters, the rest being machines of the induction type to run in multiple with the exciters.

If, as might be expected, solid iron is found to act as well in induction machines as laminated iron surrounded by a short-circuited winding, a considerable economy might be effected in such generators as those at Niagara by substituting a solid steel ring for their massive field magnets.

Transformer Regulation.

BY JOSEPH BIJUR.

While engaged in testing the regulation of various types of transformers there appeared to be a tendency among those who experimented with this class of apparatus to ascribe any drop of potential, not directly traceable to resistance, to magnetic leakage, partly because this was the most plausible reason, and in part because there seemed to be no tangible theories or data leading to a more complete solution of this important problem. With the object of investigating this question, a number of transformers were constructed, and wound so that the E. M. Fs., currents and magnetic leakage of each could be separately measured and studied.

The first whose action was thus analyzed was a ring core transformer, made by laying a number of thin, flat, soft sheet iron rings on top of one another, insulated by oxidation, until a ring, nine inches in internal diameter, four inches broad on its face, and one inch thick, was formed, the whole being insulated by a layer of shellaced paper. Over this 40 equally spaced coils of No. 20 wire were wound, completely covering the ring, connected so that the alternate coils formed the primary and secondary. Each consisted of 20 coils; those in the primary, with 100 turns each, were connected, four in parallel, five in series. The secondary was composed of 20 coils of 58 turns each, all in parallel. This arrangement gave 500 turns as the total in the primary and 58 for the full number in the secondary, with 125.7 cubic inches of iron in the core. The primaries, on account of their greater number of turns, were 5-16 inch deep, whereas the height of the secondary winding was only ⅛ inch.

The object of distributing the winding in this manner was to obtain a perfectly symmetrical arrangement of primary and secondary, spreading the magnetizing turns over the whole length of iron, so that the difference of magnetic potential through a given length should be a minimum; these conditions producing, presumably, the smallest magnetic leakage, on the principle that, with a perfectly solenoidal distribution, there can be no external magnetism.

In one of the primary and one of the secondary coils a number of exploring turns of No. 30 B. & S. wire were introduced, wound in alongside of the main wire, so that any lines of force cutting the primary and secondary would necessarily pass through the exploring turns alongside of them. As No. 30 wire was small enough to lie flush with the main wire, these two coils were not appreciably different in shape or size from their companions.

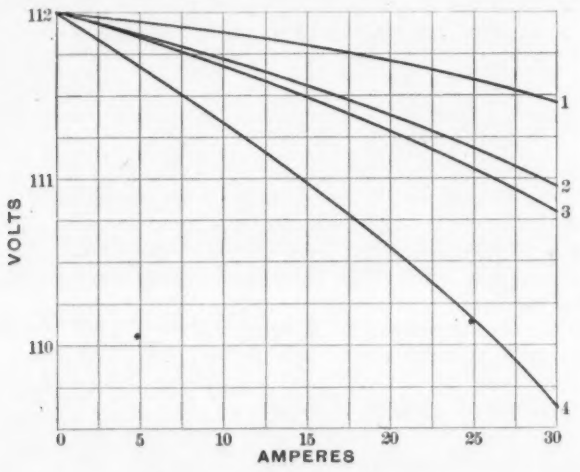


Fig. 1.

In order to ascertain whether the distance from the iron, represented by the space between the upper and lower layers of a coil, reduced the number of lines cutting the outer wire, the primary was connected to the mains of a Fort Wayne alternator of about seven kilowatts capacity, which was brought up to a speed maintained constant throughout all the experiments. Readings were then taken with an alternating volt-meter of the semi-portable type, and it was found that, both with and without load, the values obtained from the outer exploring layers were identical with those given by the inner, proving that the distance between the outer and the inner layers of wire, which was 3-16 of an inch, had no measurable effect on the magnetic leakage.

The next step was to ascertain the drop of potential with load in the same transformer. The alternator was run with some load until its temperature reached a mean and became steady, a special voltmeter controlling its potential. The transformer was then thrown in, and allowed to warm up, when all connections were broken, and the resistance of the primary and secondary measured hot, and found to be 2.25 ohms for the former and 0.072 for the latter. Again closing the circuit, the secondary, which worked at 110 volts, was loaded with incandescent lamps while current readings were taken with a recently calibrated Siemen's dynamometer. A voltmeter was so arranged that the voltage of the primary and secondary exploring turns could be taken almost simultaneously.

Beginning at no secondary load, a complete set of readings was taken and plotted, as shown on Fig. 1. Looking at the lowest curve, we see that the actual drop in the secondary, with a load of 30 amperes, was 2.3 volts. Of course, a part of this drop is caused by secondary resistance, the effect of which is eliminated by taking the readings of the secondary exploring turns, which carry no current. The curve immediately above the lowest is plotted in this way, and the height of curve 3 over curve 4 represents that part of the secondary drop caused by the resistance of the secondary winding.

Since the exploring coil wound in the secondary measures directly the number of lines of force cutting the latter, and the primary exploring coil performs a similar function, the difference between their readings measures the difference in the number of lines of force cutting the primary and secondary, which is, of course, the magnetic leakage. As curve 2 is plotted from the readings of the primary exploring turns, its height over curve 3, which is obtained from the secondary exploring coil, measures that part of the drop in the secondary due to magnetic leakage. A striking fact brought out by these curves is that less than one-sixth of a volt, or 6.5 per cent. of the total drop is directly caused by magnetic leakage, and that, after the effect of resistance has been eliminated, only 21 per cent. of the remaining loss in pressure is attributable to it.

In fact, in a well-designed transformer, the drop due to leakage is the smallest part of the whole loss, although all of the drop represented by curve 3 is commonly assigned to it.

Of this, a part is the effect of the resistance drop in the primary on the potential of the secondary circuit and the exploring coils, whose influence is to reduce the potential of the secondary by its own value, divided by the ratio of transformation. Knowing the primary resistance and current, the drop in the primary is obtained. Dividing this value by the ratio of the windings gives the corresponding drop in the other windings due to it. By subtracting this from the readings plotted in curve 2, we obtain curve 1, from which the entire resistance drop in the transformer, as well as the leakage, has been eliminated. Its height over curve 2 indicates what portion of the secondary drop results from *IR* drop in the primary.

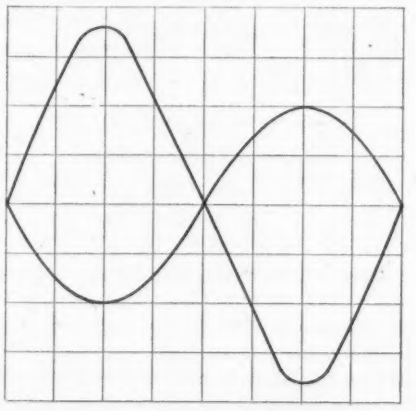


Fig. 2.

The significance of the slope of this curve is that, after allowing for loss of potential due to magnetic leakage and the hot resistance of both primary and secondary, a diminution in the number of lines of force cutting the primary—the total induction, in other words—takes place, a phenomenon whose existence does not appear to have been previously noted.

A brief consideration will show that, as the primary takes more current with load, the phase of counter E. M. F. and the resistance remaining constant, its counter E. M. F. must be reduced. As this is determined by the total induction of the core, if the primary takes more current, and if its counter E. M. F. diminishes, it follows that the induction in the core must be decreased.

The amount by which it diminishes is determined by the resistance of the primary, a very small decrease producing a large increase of current where the primary resistance is low; the necessary drop of total induction to produce a given increase of current becoming greater in proportion to the resistance of the primary.

In this there is an analogy between the transformer and the direct current shunt motor, whose low resistance armature slows down but little to diminish the counter E. M. F. enough to draw more current with load. The higher the armature resistance, the greater the slowing down, other conditions, such as field strength and distribution, remaining the same.

It is evident, then, that the primary resistance plays a twofold part; it affects the secondary potential by its own *IR* drop, and determines the diminution of core induction required to pass the primary current corresponding to a given secondary load.

The relative value of the direct causes of drop at full load in the ring transformer, which may be considered to be a fairly well designed transformer is as follows:

Secondary resistance	49.1 per cent.
Diminution of core induction	23.1 per cent.
Primary resistance	21.3 per cent.
Magnetic leakage	6.5 per cent.

Although some observers claim that the core loss in a transformer, with increase of load, remains constant, experiments by Messrs. Ryan, Merritt, Kapp and others have shown a decrease in core loss with load for which there appear to be four reasons:

(1) Magnetic leakage diminishes the induction, and consequently the hysteresis, in that part of the iron circuit covered by the secondary winding.

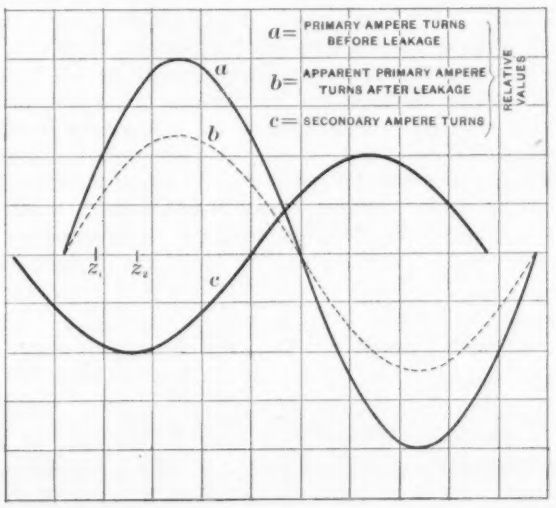


FIG. 3.

(2) The total induction and attendant hysteresis of the whole core is lessened owing to the effect of primary resistance, as pointed out above.

(3) The eddy currents are reduced by a small amount, owing to the drop in their potential, corresponding to that in secondary circuit itself.

(4) The hysteresis is diminished by the heating of the iron.

In order to understand the action of those forces whose physical relations have already been considered, it is necessary to examine their wave forms and phase changes. For this work the phase-measuring device of Dr. Duncan was used, consisting, as is well known, of several dynamometers, through whose stationary coils an alternating current is passed, while through the movable coil flows a series of impulses, whose relation with the phase of the alternating current can be changed and controlled by means of a movable contact point, touching another contact on the armature shaft. In this way the curves of the primary E. M. F., shown in Fig. 2, were obtained, the high peak of the former denoting the presence of a third harmonic, while the secondary E. M. F. is similar, but more flattened at the top.

With no load the curves of primary, counter and secondary E. M. F. pass through the same zero. As the load increases, the secondary E. M. F. remains stationary, while the primary E. M. F. advances, followed by the counter E. M. F. The difference between the zeros of the primary and counter E. M. Fs. is very small, while between the counter and the secondary there is a considerable interval. As the only physical difference between them is magnetic leakage, we have here the first direct proof that the lag of secondary, behind primary, E. M. F. with increasing load is caused by leakage.

In order to understand why leakage not only lessens the value of the secondary E. M. F., but causes it to lag as well, we must consider the graphical relation of the primary and secondary current curves before and after leakage takes place. The effect of leakage is to diminish the number of lines of force (through a given section of the iron) produced by the primary current. In other words, it acts as if the primary current had been diminished. This condition is shown graphically in Fig. 3 where the plain lines show the magnetizing force of a primary and a secondary current, whose resultant will have a zero value at the point Z_1. The dotted line shows an exaggerated decrease of the primary (for the sake of clearness), the zero of whose resultant with the same secondary will be at Z_2, some distance behind Z_1, thus demonstrating how a decrease of primary current, or magnetizing force, of which leakage is an equivalent, will produce a lag in the magnetizing resultant, and consequently the secondary E. M. F., whose phase is dependent on it.

In the course of these experiments the breaking down of a dynamometer prevented the complete determination of the relation of the current to E. M. F., but as this has been very fully investigated by Prof. Ryan, a study of the diagrams obtained by him will suffice to show the effect of the phase advance in the primary current. He found that the secondary current is in phase with the secondary E. M. F. at all loads, which is to be expected when we remember that its circuit through incandescent lamps is practically non-inductive. The important point brought out in his investigation is that the primary current, which has a large lag at no load, moves forward as this increases until it is nearly

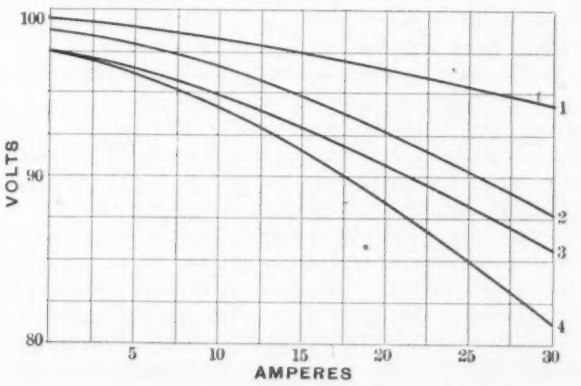


FIG. 4.

in phase with the primary E. M. F. and more directly opposed to the secondary current.

Considering the case of two equal and similar current curves, 180 degrees apart, it is evident that the sum of their ordinates, and, consequently, their resultant current, will be equal to zero. As the difference in their phase diminishes by the movement of either, their resultant increases in value until, when the curves coincide in phase, its value is measured by the sum of their ordinates, showing that the resultant varies in some inverse proportion to their phase difference.

In the case of the transformer there is a difference on open secondary of more than 90 degrees between the primary and secondary currents, whose magnetizing influence on the iron is nearly equal. The advance of the primary current with load increases this difference, diminishing the magnetizing resultant, as explained above, and consequently the total induction through the whole of the iron core. This is the cause of the drop shown by curve 1.

Contrary to expectation, it is found that on loading the transformer the E. M. F. of the secondary stands practically still, while the primary moves forward. As the secondary load is a non-inductive, its current and E. M. F. keep the same phase relation throughout, and both remain nearly stationary at all loads.

In order to test the working of commercial apparatus, the experiments described were repeated on a Stanley 50-light and a Westinghouse 10-light transformer of an old type with similar results. The latter was rewound, with exploring turns in the primary and secondary, one layer of fine wire next to a layer of the main wire. The drop of potential in the Westinghouse transformer is shown, Fig. 4, where curve 4 is the actual drop in the secondary circuit, curve 3 the drop in the secondary exploring coil, curve 2 the drop in the primary exploring coil, and curve 1 the drop due to decreased magnetic induction, calculated as before. Comparing Fig. 4 with Fig. 2, we notice first that the drop in volts in every curve is much greater in the former, due partly to the greater resistance of the primary and secondary, and partly to the increased magnetic leakage, the result of an unsymmetrical arrangement of the winding. The primary of this Westinghouse transformer measured, warm, 14.25 ohms, the secondary 0.14 ohms. We see that the difference between curves 3 and 4 on both plates is nearly the same relatively; but between curves 2 and 3 there is a marked contrast, showing that the magnetic leakage of the Westinghouse transformer is much greater than that of the ring transformer. Also, the difference between the curves 1 and 2 for the Westinghouse transformer is considerably more on account of the high primary resistance. Comparing curves 1 in each case, it is clear that the diminution of induction in the core of the Westinghouse transformer is about five times greater, on account of its high primary resistance. This leads us to conclude that, if the primary resistance were zero, curve 1 would become a straight horizontal line, which is equivalent to saying of the analogous case of the direct current shunt motor, that, were the armature resistance zero, all other conditions remaining the same, the speed would remain constant for any load.

In measuring the phase relations, identical curves for both transformers were obtained, except that in the Westinghouse transformer the shifting of the primary E. M. F. forward (or of the secondary E. M. F. backward) with increasing secondary load was greater, an effect already shown to be due to magnetic leakage.

Mr. Kapp, in the *Electro-Techniker Zeitschrift* of April 25, 1895, mentions the fact that the introduction of capacity into the secondary circuit tends to raise its voltage. This confirms the deductions mentioned, since the effect of capacity is to bring the phase of the secondary current forward, lessening the phase difference between it and the primary current, lessening the amount of their opposition, and increasing the resultant magnetizing ampere-turns on which the total induction and secondary E. M. F. depend.

The effect of hysteresis and Foucault currents is equivalent to a constant addition to the secondary load. An inspection of Fig. 1 shows that the slope of the curves, that is, the amount of drop for a given increase of current, is greater as we go further from the line of no current. The effect of these losses is to shift the current values to the right, i. e., assuming the united loss to be equivalent to an ampere of secondary current, at 20 amperes useful secondary load the drop would have a slope corresponding to 21 amperes. The effect of hysteresis and eddy currents on the phase of the primary current is to shift it forward. Hence we may conclude that an ideal transformer in which the primary and secondary resistances, hysteresis and Foucault currents were all zero, would have no drop of secondary potential with increase of load, which is equivalent to saying that the condition for constant secondary potential is perfect efficiency.

Returning to actual transformer conditions, it is clear that, in order to obtain good regulation, the iron should be worked at such a magnetic density that it is well up in the horizontal portion of the magnetization curve, as at this point a given diminution of magnetic current produces the smallest decrease of induction, and consequently less drop, than would occur lower down. It is also evident that the slope of the curve of secondary potential is less at light loads, showing that, for good regulation, the load should be small compared to the size of the transformer.

Finally, we may review the several causes which produce a drop of secondary potential with load in commercial transformers as follows:

(a) A drop due to a decrease in the induction in the iron following an excessive phase advance of the primary current, inherent in all present types of transformers.

(b) A drop due to a diminution of the effective primary E. M. F., caused by the primary resistance.

(c) A drop due to the magnetic leakage, which acts by shifting the secondary E. M. F. and current back toward and in opposition to the primary current.

(d) A drop due to the resistance of the secondary circuit.

(e) A drop due to the increase of primary and secondary resistances with rise of temperature.

It appears to be advisable in the construction of transformers, with a purpose of attaining good regulation, to distribute the windings symmetrically, and as close together as is consistent with safety, to use the best quality of iron and as great a magnetic density as hysteresis loss will permit.

Meeting of the French Society of Electricians.

At the meeting held on March 3 M. Blanchon made a report upon the rapid charging of Tudor accumulators. He showed that these apparatus permitted very high discharge without their useful capacity falling below a certain normal limit; also that an accumulator of a capacity of 100 ampere hours, discharged after ten hours, gave a capacity of 30 amperes for a half hour; 45 ampere hours in one hour and 65 ampere hours in two hours. These accumulators will probably be used upon the railway line at Peteaux. The charge will be made at constant potential, and the elements will take, in twenty-one minutes, 46 per cent. of their normal charge. M. Arnous has made a charge of a Blot element in five minutes with 30 amperes of current per kilogram of electrode. M. Margaine has made, as well as M. Picou, experiments on rapid charge of three Blot elements of 8½ kilograms each. After five minutes' charge the element had received 2.28 ampere hours per kilogram of the electrodes, and gave back 60 per cent. of the energy. After fifteen minutes of charge the useful capacity was raised to four ampere hours per kilogram. M. Dieudonne read a long note from M. Francq upon mechanical traction in Paris. M. J. Laffargue referring to the communication made by M. Bonfante at the last meeting criticised the installations of interior conduits in dwellings. He examined in detail the allegations made by M. Bonfante, and showed that, taking the precautions indicated by the ordinary rules for metallic gas and water pipes, the electrical contractors had made very excellent installations.. Attention was called to the defective construction of the circuit-breakers in ordinary use. After a short reply by M. Bonfante, the meeting ended.

Rapid Transit Act Declared Constitutional.

The Court of Appeals, at Albany, on March 23, affirmed with costs the judgment of the lower court in the case of The Sun Printing and Publishing Company and others, appellants, against the Mayor and other authorities of New York City, the Board of Rapid Transit Commissioners and others, respondents. This was an appeal by plaintiff from a judgment of the Appellate Division, First Department, affirming the judgment of Special Term, dismissing the complaint. The question involved is the construction of the Rapid Transit Act of 1891 as amended, and more particularly, the plan of municipal construction provided by the act of 1894. The plaintiffs, as taxpayers, brought action to restrain what they asserted to be the unlawful expenditure of public money. They sought a judgment declaring the rapid transit act to be unconstitutional; to restrain the Board of Estimate and Apportionment from appropriating any money under the provisions of those acts, for payment to or on behalf of the Rapid Transit Board, and to restrain the Controller from issuing and selling bonds to provide money for the payment of charges incurred by the Rapid Transit Board. The decision upholds the constitutionality of the railroad act. It is stated that the Rapid Transit Commission will now advertise for bids for the construction of the underground rapid transit road, the plans for which have been substantially approved by the municipal authorities.

The Design of Direct-Current Machines with Reference to Sparking.

BY J. FISCHER-HINNEN.

(*Continued from page 387.*)

Let t represent the time during which a coil is short-circuited through the brush. With reference to Fig. 4, it will be seen that

$$t = \frac{\gamma\, 60}{D_1\, \pi\, n} \quad . \quad . \quad . \qquad \text{(I)}$$

Lastly, the determination of the coefficient of self-induction L can only be made approximately.

It will be necessary to consider four cases.

(*a*) TOOTHED ARMATURE.

Let U represent the conductivity of the magnetic circuit, which is formed around the short-circuited coil. Only those lines of force which surround this coil will be taken into consideration, and, furthermore, it may be assumed that the remainder are taken up by the entire armature winding; for the same reason we may neglect the leakage due to the frame.

Hence, for toothed armatures, Fig. 6:

$$U = \frac{4\,\pi\, l}{10}\left[\int \frac{dx}{\pi x} + \frac{y}{2x}\right] = \frac{4\,\pi\, l}{10}\left[\frac{2.3}{\pi}\log\frac{x_1}{x} + \frac{y}{2x}\right]$$

In general practice it is commonly found that

$$\frac{x_1}{x} = 3 \text{ and } \frac{y}{2x} = 3$$

and, further, when we take into consideration that inside the tooth

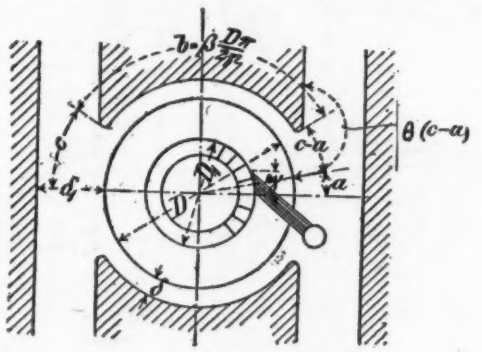


FIG. 4.

only 50 per cent. of the lines of force are used, we can safely say that $U = 2.3\, l$.

(*b*.) HALF-CLOSED TEETH.

For the usual proportions,

$U = 3\, l$ approximately.

(*c*) IRON-CLAD ARMATURES (THE COILS COMPLETELY SURROUNDED BY IRON.)

For this class of armatures U is apparently still greater; in this case, however, the conditions are so complicated that it is impossible to give a simple solution. In this case we will put $U = 3.5\, l$.

(*d*.) SURFACE WOUND ARMATURES. (FIG. 7.)

Approximately

$$U = \frac{4\,\pi}{10} \cdot \frac{l\, r}{\pi\, r} 0.5 = 0.2\, l$$

From this we have in general

$$L = U \,.\, \frac{N^2}{N_1\, N_2} \,.\, \frac{1}{10^8} = \frac{U\, l\, N^2}{10^8\, N_1\, N_2} = \frac{U\, l\, N\, q}{10^8\, N_2} \quad . \quad . \quad . \qquad \text{(K)}$$

where $N_1 = N/q$.

From equations (G) to (K) we deduce

$$\frac{r\, t}{L} = \frac{\varepsilon\, E\, 4\, p_1^2\, \gamma\, 60\,.\, 10^8}{J\, D_1\, \pi\, n\, U\, l\, N\, q} \quad . \quad . \quad . \qquad \text{(L)}$$

In this equation we can substitute for E its value

$$E = \frac{N\, n\, \Phi\, p}{60 \times 10^8\, p_1\, (1 \pm \varepsilon')} = \frac{N\, n\, D\, \pi\, \beta\, l\, B}{60 \times 10^8\, p_1\, (1 \pm \varepsilon')\, 2} \quad . \quad . \quad . \qquad \text{(M)}$$

where Φ is the total flux per pole.

For generators $(1 + \varepsilon')$ must be used, and for motors $(1 - \varepsilon')$ must be used.

Therefore,

$$\frac{r\, t}{L} = \frac{2\, D\, \beta\, p_1\, \gamma\, \varepsilon}{D_1\, J\, U^1\, (1 \pm \varepsilon')\, q} \quad . \quad . \quad . \qquad \text{(N)}$$

The equations (L) to (N) readily permit us to calculate the value of $\frac{r}{L}\, t$ from the dimensions of the machine, as has been done in Table II.

Since the corresponding values of η $\frac{E_2}{E_1}$ and $\varepsilon + \frac{r}{L}\, t$ can be taken from Table I, these formulæ will be sufficient to develop the following important equations of limiting conditions.

Calculation of the current which is interrupted by any shifting of the brushes.—To solve this problem, we calculate the value of $\frac{r}{L}\, t$ from equation (L) or (N) and substitute this new value in equation (D).

Shifting of the Brushes.—An important factor in the design of a machine is the relation between the distance a—see Fig. 8—*i. e.*, the distance through which the brushes must be shifted from the neutral line, and the distance c from the edge of the pole piece to the neutral line.

The nearer this relation approaches unity, the more difficult does it become to set the brushes, while, moreover, the least variation in brush position has the most pronounced influence on the voltage, E_2. This may be seen by tracing the curve E_2 in Fig. 8. In Table III are shown the limits for sparkless commutation.

The magnetic density at any point, G (Fig. 8), will be altered by shifting the brushes through a distance a. This point G is under the magnetic influence of two poles. If B is the maximum density directly under the pole, then at the point G the density will be:

$$B^1 = B\,\frac{\delta}{\theta\,(c-a)+\delta} - B\,\frac{\delta}{\theta\,(c+a)+\delta} \quad - \quad - \quad - \qquad \text{(O)}$$

Substituting this value in the equation,

$\eta = E_2/E_1$

gives us as a result

$$\eta = \frac{\delta\, a\, \theta\, (1 \pm \varepsilon')^2}{[(\delta + \theta\, c)^2 - \theta^2\, a^2]\, \beta\, \varepsilon}$$

and finally,

$$a = \sqrt{M^2 + (c + \frac{\delta}{\theta})^2} - M \quad - \quad - \quad - \quad - \quad - \qquad \text{(P)}$$

Where

$$M = \frac{\delta\,(1 \pm \varepsilon')}{\theta\, \beta\, \varepsilon\, \eta} \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad - \quad - \qquad \text{(R)}$$

The dimensions of the machine give the values of δ, b and β; ε and ε' depend on the "lost volts" of the machine. For the sake of simplicity we may put $\varepsilon' = 2\varepsilon$ approximately. And finally η can be determined with the aid of Table I.

If we should wish to derive a graphically, which would be desirable in many cases, it is only necessary to put:

$$FH = \left(c + \frac{\delta}{\theta}\right)$$

and $HK = M$.

and to connect points K and F.

If, now, MHK is revolved around K as a center until it comes into coincidence with the line KF, it will locate the point L, where $HK = KL$.

If now FL is revolved around F as a center, it will locate the point G, where

$FG = FL = a$,

G being the point in question.

In equation (P) it is seen that in machines with a small air-space, $\frac{\delta}{\theta}$, in comparison with c, is exceedingly small, and may be neglected.

In Tables II and III will be found a great amount of data referring to the construction of machines of various makes and designs. These figures were given to me by the different manufacturers.

Of the machines tested, numbers 1–8 ran very well—as it was difficult to determine which machine ran the best—the machines were put down in the ascending order of the values of $\frac{a}{c}$. Num-

bers 9 and 10 were good, numbers 11–16 fair, while numbers 17–20 were so bad that they were useless, and had to be completely changed.

This result agrees in general with the calculations, especially in regards to the value of a/c. The few exceptions are easily accounted for by tracing the variations back to their sources.

So far we have neglected the contact-resistance of the brushes. In machines with copper brushes this is allowable, but when carbon brushes are used a correction factor must be introduced.

Investigations of Guilbert and Giles give the following contact-resistance of the brushes. The contact area being given in square millimeters:

Velocity of Commutator in Meters.	Contact-Resistance per sq. Mm.
0	1 ω
6	2 ω
12	5 ω

These values seem unusually large, probably due to the poor material in the commutator (bronze).

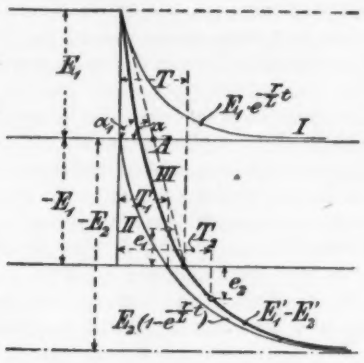


Fig. 5.

If we take one-half the cross-section, we find in Machine No. 7, the contact-resistance of the brushes to be $= \frac{2.5}{5250} = 0.0005\omega$. while the resistance per coil is 0.00188ω.

The resistance will be further increased about 27 per cent.; then we have

$$\frac{r}{L}t = (1.27)\,0.85 = 1.08\,;\ \eta = 2.03\,;\ a = 4.5 \text{ cm.}\ \frac{a}{c} = 0.385.$$

In the motor No. 12, the value of $\frac{a}{c}$ as given may be greatly diminished for another reason which will be set forth later on; for the present it may be stated that $\frac{a}{c} = 0.65$.

In the machine No. 9, though the value of $\frac{a}{c} = 0.04$ only, still it cannot be said that the machine worked extremely well for the simple reasons that it was difficult to place the 24 brush holders with 144 brushes accurately. Nevertheless, with some trouble, it was possible to arrive at a position of *almost* no sparking.

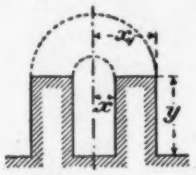


Fig. 6.

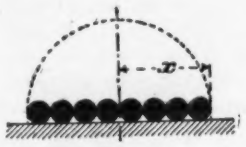


Fig. 7.

The dynamo No. 11 ran in general very well, but a fault in design was very apparent. The difference in voltage between adjacent commutator segments was so great that often there would be a "flash" all around the commutator.

In such a case, the use of carbon brushes is not to be commended.

Such a fault could not, naturally, be allowed for in the above calculations.

In the machines Nos. 9 and 10 the results of the calculation and the tests agree very well.

No.	Ampere.	Change in Brush Position. By experiment.	By calculation.
9	250	15°	15.1°
10	500	27°	26.6°

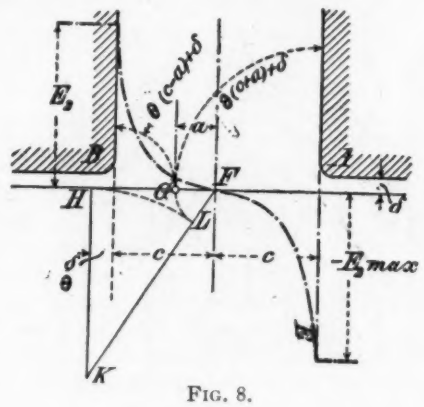


Fig. 8.

SPARKING.

Shifting of the brushes and sparking are closely allied. This is a very well-known fact, as a result of experience; but it may also be shown by theory.

Without going too far into the depths of the imaginary, we can,

TABLE II. VALUES OF $\frac{r}{L}t$ FROM EQUATION N.

	G = Generator. M = Motor.	Kilowatt.	Revs. per Min.	Amperes.	Type.	Number of Poles.	Winding.	Armature Construction.	Brushes.	N_2	δ cm	δ'_1 cm	θ	D cm	β	B	p_1	y cm		D_1 cm	J	ω^1	$1+\varepsilon^1$	q	$\frac{r}{L}t$	η
1	G	62.5	600	125	.....	6	Drum.	Smooth.	Copper Brushes.	176	1.4	11.	2.1	70	0.73	5100	1	0.9	0.016	50	125	0.2	1.03	2	2.9	1.12
2	G	5.	1600	50	Manchester.	2	Ring.	"	"	46	0.95	11.2	2.	24.5	0.75	2900	1	1.0	0.035	11	50	0.2	1.07	4	7.7	1.01
3	G	43.2	750	24	"	2	"	"	"	140	1.0	12.	3.	51	0.84	4100	1	0.8	0.023	35	24	0.2	1.05	8	4.6	1.02
4	G	10.	1200	100	"	2	"	"	"	50	1.0	10.	2.	29	0.72	3500	1	1.0	0.04	13.5	100	0.2	1.08	3	6.7	1.01
5	G	20.	800	200	"	2	"	"	"	72	1.5	11.	2.	42	0.65	3000	1	1.0	0.042	20	200	0.2	1.08	2	4.0	1.03
6	M	10.	285	20	.....	4	Ring with Series Winding	"	Carbon Brushes.	113	1.4	6.	1.57 2.1	35	0.55	4400	1	1.0	0.06	26	20	0.2	0.88	12	9.3	1.06
7	G	196	300	370	.....	4	Drum.	Slotted.	Carbon Brushes.	244	1.0	30	2.5	115	0.74	6000	2	2.5	0.02	68	370	2.3	1.04	2	0.85	2.5
8	G	50	600	400	.....	4	"	"	Copper "	112	0.75	15	2.1	56	0.615	6300	2	1.2	0.021	26	400	2.3	1.04	2	0.445	4.5
9	G	413	150	7500	Vertical.	24	"	Smooth.	" "	216	2.45	8.8	1.6	237	0.64	6600	1	3.0	0.016	170	7500	0.2	1.03	2	2.2	1.27
10	G	40	700	320	.....	4	"	Slotted.	" "	61	0.6	11.5	2.3	41	0.66	6500	1	1.1	0.04	20	320	2.3	1.08	1	0.97	2.20
11	M	210	260	150	.....	10	"	Smooth.	Carbon "	256	2.0	14.	1.8	150	0.72	6200	1	1.8	0.02	90	150	0.2	0.96	3	6.2	1.015
12	M	15	450	30	.....	4	Ring with Series Winding	Half Closed Slots.	" "	119	0.2	12.	2.1	40	0.63	7400	1	1.0	0.048	25	30	3.0	0.90	12	0.735	2.85
13	G	40	300	180	.....	4	Drum.	Half Closed Slots.	Copper "	48	0.5	4.7	1.6	50	0.85	7000	1	1.2	0.026	32	180	3.0	1.06	4	0.254	7.9
14	G	20	650	1000	.....	6	"	Iron Clad.	" "	39	0.15	7.4	2.1	48	0.73	8000	3	1.7	0.026	27	1000	3.5	1.05	1	0.75	2.8
15	G	2.5	1300	20	.....	2	"	Slotted.	" "	50	0.35	5.0	2.35	18	0.51	6200	1	0.8	0.053	11.5	20	2.3	1.10	8	1.04	2.1
16	G	4.5	1200	36	.....	2	"	"	" "	44	0.4	5.5	2.35	18	0.51	5550	1	1.0	0.048	12.5	36	2.3	1.10	8	0.536	3.8
17	G	10.	1000	80	.....	2	"	"	" "	54	0.4	6.	2.35	24	0.49	7200	1	0.8	0.030	15.	80	2.3	1.06	4	0.35	5.8
18	G	10.	1200	1000	Manchester.	2	"	Iron Clad.	" "	11	0.4	9.	2.	25	0.87	4000	1	2.0	0.035	18.	1000	3.5	1.10	1	0.175	11.5
19	G	48	500	400	"	2	"	Slotted.	" "	60	0.3	11.	3.2	51.5	0.76	5000	1	1.0	0.036	24	400	2.3	1.07	2	0.298	6.8
20	G	60	500	500	"	2	"	"	" "	70	0.6	12.	3.2	62.2	0.70	3950	1	1.0	0.04	29	500	2.3	1.08	2	0.191	10.0

nevertheless, set up a probable hypothesis from the analogy of these to ordinary phenomena. *The amount of sparking bears a direct and definite proportion to the amount of energy interrupted; and an inverse proportion—not yet definitely known—to the velocity with which this interruption is accomplished.* All that we know with reference to the latter is that it increases as the resistance increases. (See Fig. 8). At the instant when the short-circuit is broken, the entire armature resistance, plus the air-resistance of the arc, is included in the circuit. From this fact we can imagine with what exceeding velocity this action takes place, and hence it is easily understood why commutators spark less than ordinary switches.

In order to have sparking, therefore, we must necessarily predicate a change in the amount of energy. And as it has been shown before that it is possible to find such a brush position that there will

TABLE III. VALUES OF $\frac{\delta}{\delta_1}$ FROM EQUATION R AND $\frac{a}{c}$ ——

	G=Generator. M=Motor.	$\frac{T}{L}\frac{t}{r}$	η	θ	β	ε	δ	$(1 \pm \varepsilon^1)$	M	c	$\frac{\delta}{\delta_1}$	$\sqrt{M^2+(c+\frac{\delta}{\delta_1})^2}-M$	a	$\frac{a}{c}$
1	G	2.9	1.12	2.1	0.73	0.016	1.4	1.03	52.5	4.95	0.66	52.75 — 52.5	0.25	0.05
2	G	7.7	1.01	2.	0.73	0.035	0.95	1.07	19.2	4.8	0.475	20. — 19.2	0.8	0.167
3	G	4.6	1.02	3.	0.84	0.023	1.0	1.05	17.8	6.4	0.33	19. — 17.8	1.2	0.187
4	G	6.7	1.01	2.	0.72	0.04	1.0	1.08	18.5	6.35	0.50	19.8 — 18.5	1.3	0.205
5	M	4.0	1.03	2.	0.65	0.042	1.5	1.08	29.	11.5	0.75	31.5 — 29.	2.5	0.218
6	G	9.3	1.00	1.8	0.55	0.06	1.4	0.88	20.7	6.7	0.78	22. — 20.7	1.4	0.21 (0.385)
7	G	0.85	2.5	2.5	0.74	0.02	1.0	1.04	11.3	11.7	0.40	16.5 — 11.3	5.2	0.445
8	G	0.445	4.5	2.1	0.615	0.021	0.75	1.04	6.4	8.35	0.357	10.8 — 6.4	4.4	0.525
9	G	2.2	1.27	1.6	0.64	0.016	2.45	1.03	119.	5.6	1.53	119.21 —119.	0.21	0.04
10	G	0.97	2.2	2.3	0.66	0.04	0.6	1.08	4.85	5.5	0.26	7.53 — 4.85	2.68	0.49
11	M	6.20	1.015	1.8	0.72	0.02	2.	0.96	17.8	6.6	1.11	19.4 — 17.8	1.6	0.242 (0.67)
12	M	0.735	2.85	2.1	0.63	0.04	0.2	0.92	1.22	6.0	0.595	6.308— 1.22	5.088	0.85
13	G	0.254	7.9	1.6	0.85	0.026	0.5	1.06	1.9	3.0	0.31	3.83 — 1.9	1.93	0.645
14	G	0.75	2.8	2.1	0.73	0.026	0.15	1.05	1.41	3.4	0.071	3.74 — 1.41	2.33	0.685
15	G	1.04	2.1	2.35	0.51	0.053	0.35	1.10	2.88	6.9	0.15	7.63 — 2.88	4.75	0.69
16	G	0.536	3.8	2.35	0.51	0.048	0.40	1.10	2.0	6.9	0.17	7.35 — 2.0	5.35	0.775
17	G	0.35	5.8	2.35	0.49	0.039	0.40	1.06	2.1	9.6	0.17	10. — 2.1	7.9	0.823
18	G	0.175	11.5	2.0	0.87	0.035	0.40	1.10	0.63	2.55	0.20	2.82 — 0.63	2.19	0.86
19	G	0.298	6.8	3.2	0.76	0.036	0.30	1.07	0.54	7.5	0.10	7.619— 0.54	7.08	0.945
20	G	0.191	10.	3.2	0.70	0.040	0.60	1.08	0.72	15.0	0.19	15.2 — 0.72	14.48	0.965

be no change in energy under the condition that $a < c$, it appears, therefore, inexplicable that, even in the best machines, small sparks should be seen at the brushes.

The reason for this is simply on account of the variation in brush-contact and in the unequal resistances of the soldered joints. The more soldered joints, the greater tendency to sparking; at the same time it is absolutely impossible to obtain an exactly equal resistance in all the commutator segments, and even more so when the machine becomes warm. In many machines this is excluded by the nature of the winding.

If now the brushes are set right for one segment, for the next it may possibly not be in the right position, and the result is a small spark.

The inequalities in the soldered joints are best observed when a commutator is worn down unequally.

(*To be continued.*)

The Insulating Medium Surrounding a Conductor the Real Path of Its Current.*

BY E. J. HOUSTON AND A. E. KENNELLY.

In view of the fact that at the present day old phraseology and old methods of treatment are still almost universally employed in explaining electrical phenomena, and also considering the splendid work of Maxwell, Hertz and Heaviside, whose theories lead to the belief that electric currents are transmitted as electric waves through the ether surrounding a conductor, being guided by the conductor, but not transmitted through it, the authors considered that a brief description of the manner in which electric current is believed to be transmitted might aid in disseminating these more modern views. All electric, magnetic or electromagnetic phenomena are now believed to be referrable to two conditions of stress in the ether, one of which is called electric flux and the other magnetic flux. The exact nature of either is unknown.

The electric transmission of power consists in transferring electric and magnetic flux to a distance and allowing these fluxes to be expended in liberating at the receiving end of the line, the energy they contain. An electric generator is a machine for producing electric flux and thus transferring electric flux to the other.

There are three standard types of conductors and their associated, intervening, insulating medium.

1. An aerial conductor such as a telegraph wire supported sensibly parallel to the surface of the ground. Here the wire forms one conductor, the ground the other conductor, while the other associated with the air between them is the medium through which the electric current flows.

2. Subterranean or submarine conductors separated from the surrounding conducting earth or water, by a uniform layer or coating of insulating material. Here one conductor is formed by the interior wire, while the other conductor is the sheath of metal, liquid or ground, and the medium through which the electric current flows is the ether and the insulating coating of rubber, gutta percha, paper, etc., with which the interior conductor is invested.

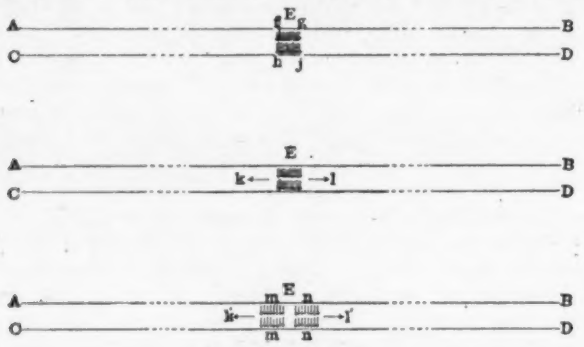
3. A pair of overhead wires supported sensibly parallel to each other on suitable insulating supports, as, for example, a pair of telephone or electric light conductors. Here the two wires are the conductors, and the medium through which the electric current flows is the layer of ether and the air between them.

When an electric source is connected to any such pair of conductors, the electric flux is established in the insulator between them, or, more correctly speaking, in the ether terminating the insulator. The density of the electric flux, or the quantity of flux per normal square centimeter, will depend upon the nature of the insulator, on its dimensions and on the electric pressure or voltage of the source. An increase of voltage is attended by a proportionate increase in the density of the electric flux; while an increase in the thickness of the layer of insulating material between the conductors diminishes the density.

In order to study the electric transmission of power over a circuit, we may suppose that a pair of perfectly conducting wires exists extending between two cities, as represented in Fig. 1. At the middle of the line, E, we may suppose that suitable short lengths of each of the two wires, namely f, g, and h, j, each one meter in length, are insulated from the rest of the system, and electrically charged by a momentary connection to a dynamo or other suitable source to a pressure to say 1000 volts. An electric flux will thus be established between the two short lengths of wire of the type represented in Fig. 1 by the arrows, f g, being positive and h j, negative. If the meter lengths at E be perfectly insulated from each other, the block of electric flux resident in the ether between them would be indefinitely maintained at 1000 volts pressure. Suppose, however, that at some instant of time, the discontinuity existing between the meter lengths of the conductors and the rest of the system are suddenly bridged over. In other words, the meter lengths are connected electrically at both ends to the rest of the circuit. Then, instantly, the flux tends to rush towards the ends of the circuit as represented by the arrows k and l in Fig. 2. The meter block of flux instantly subdivides into two meter blocks each under 500 volts pressure and each being half of the original density and therefore, one-quarter of the original energy. At the same time, the moment that the flux commences to run, a magnetic flux distribution is brought into existence. The

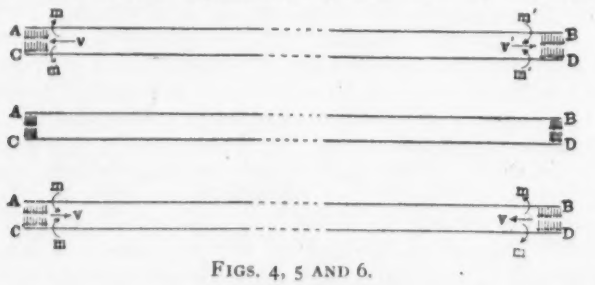
*Abstract of a paper read before the American Philosophical Society, Philadelphia, March 19, 1897.

magnetic flux at each point is due to the movement of the electric flux through the ether at that point, and is not due, as the old theory supposed, to an assumed current in the wires. The passage of the electric flux over the wires is a momentary electric current, which in this case would have a strength of, roughly, two amperes. The velocity with which the flux blocks move in Fig. 3, is the velocity of light in air; approximately 300,000 kilometres per second. If the distance from E to the end of the wires is 300 kilometres each way, the meter blocks of flux will traverse this distance in 0.001 of a second. The meter blocks, will, therefore, pass by any particular point on the line in 1/300,000,000 of a second, and the electric current, which this flux rush constitutes,



Figs. 1, 2 and 3.

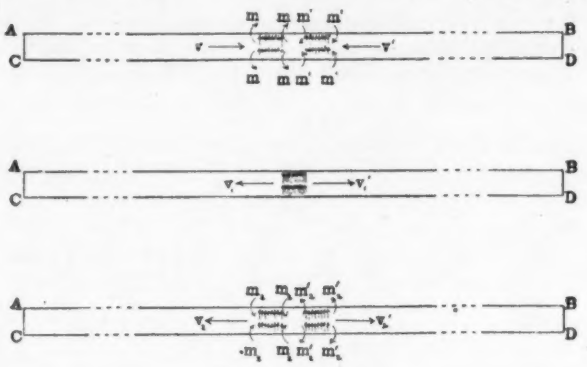
would, therefore, have this duration at any particular point. Fig. 4 represents the meter blocks of flux on arriving at the termini of the line. The two conductors are open-circuited or insulated at both ends. The arrows v and v^1 represent the direction in which the blocks arrive, the curved arrows m m and m^1 m^1 representing the direction of magnetic flux which has been generated by the movement of each block, and which has been carried bodily along with the moving blocks. If the original meter block of flux in Fig. 1 represents an amount of energy resident in the electric flux amounting to say 1000 ergs, and each of the two meter blocks into which this is divided, assuming no dissipation of energy, carries with it 500 ergs, 250 in magnetic flux and 250 in electric flux. On arrival at the termini, the flux is compressed into a half meter at each end, as represented in Fig. 5. The density of electric flux is doubled as represented by the closeness of the arrows. At the same time the magnetic flux vanishes, while the pressure rises momentarily from 500 to 1000 volts. There is, therefore, half the volume of flux with twice the density, and therefore, four times the voluminal electric energy, but no magnetic energy. Consequently, there remains 500 ergs of purely electric energy in each block. Fig. 6 represents the condition of affairs immediately afterwards. Here the blocks expand again into meter lengths and are reflected from their termini, or moved back towards the centre of the line. The magnetic flux reappears but in a reversed direction, as shown by the curved arrows. The electric flux retains its original direction from the upper to the lower wire and the pressure has fallen from 1000 to 500 volts as before. The current represented by flux rush is, therefore, re-



Figs. 4, 5 and 6.

versed, in direction, since the magnetic flux by which it is measured is reversed, but the electric potential difference as measured by the density of electric flux, remains unaltered.

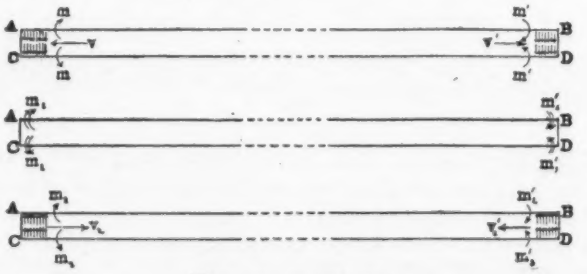
After the lapse of another 0.001 of a second, the two meter blocks will arrive again at E as shown in Fig. 7, the arrows showing the magnetic flux to be oppositely directed in the two blocks. In Fig. 8 the meter blocks are represented as having collided and mutually annulled each other's magnetic flux. The density of electric flux being doubled there will be four times the electric energy per cubic centimeter. The two blocks pass completely through each other, appearing on the opposite sides, as shown in Fig. 9. The process of meeting in the centre, separately, reaching the ends and being reflected therefrom, will repeat itself indefinitely in cycles which take 0.004 of a second to complete, the current direction reversing at each reflection from the ends. In this case, we have assumed that there is no dissipation of electromagnetic energy, there being no leakage between the two conductors and perfect conduction in the two wires. Suppose, now, that the two wires AB and CD are connected at the termini. Let the meter block of flux be started from E, the centre of the line, as in Fig. 2. The two blocks will rush over the intervening space of 300 kilometres in 0.001 of a second and will reach the ends of



Figs. 7, 8 and 9.

the line, as shown in Fig. 10, the arrows v and v^1 indicating the direction in which the blocks have arrived, the curved arrows representing the direction of accompanying magnetic flux. In this case, instead of the electric density being doubled, the electric flux vanishes completely as soon as the magnetic flux is compressed into half a meter of length. The magnetic box is, however, doubled in density as represented by the double curved arrows in Fig. 11. Here the energy is all magnetic and each half meter block of magnetic flux at the ends of the line contains 500 ergs of energy. Fig. 12 represents the condition of affairs immediately after the disappearance of the flux. The lower wire has become positive and the upper wire negative. Fig 13 shows the condition of affairs just before the two blocks meet. In Fig. 14 the magnetic flux is shown annulled, but the electric density is doubled. The two meter blocks then separate out by passing through each other as shown in Fig. 15, and undergo reflection with reversal of electric flux and persistence of magnetic flux at the termini. This condition of reflection and collision would continue forever under the conditions assumed.

The authors then take up the conditions, first, of assuming that there is imperfect insulation in the insulator and perfect conduction in the wires, and consequently, that if the insulator insulates perfectly, the wires do not conduct perfectly. For this latter purpose they consider a cable composed of a central wire and annular external conducting sheath. The meter block of flux starts from the centre as before, the interior conductor being positively and the sheath negatively electrified. Here the imperfect con-

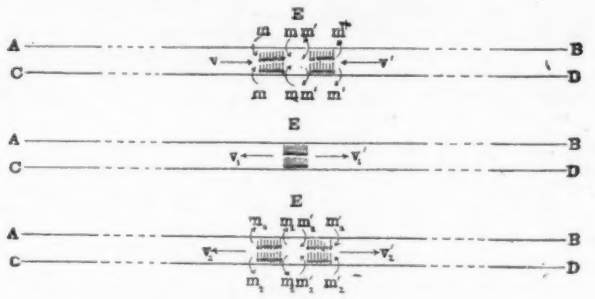


Figs. 10, 11 and 12.

duction of the wires sets up a series of straggling reflections of electric flux, in the same direction, however, as that in the moving flux. (See Fig. 16). The electric flux is bent on the perpendicular in the direction of motion, as represented in exaggeration in Fig. 17. Consequently, the meter blocks are subjected to a process of attenuation or decay, by throwing off attenuated electric flux as they advance, the straggling flux when thrown off immediately commencing to rush backwards with the velocity of light in the medium, as represented by the arrows, u and u^1. The meter blocks, therefore, lose definition as they advance, becoming weaker and weaker, the energy being lost into

the conductor and into the straggling flux. If the wires conduct sufficiently imperfectly, the two meter blocks may be completely absorbed before they reach the terminals of the line, the degree of attenuation depending entirely upon the degree of imperfection in conducting power for a given cable, i. e., a given geometrical distribution of insulating medium.

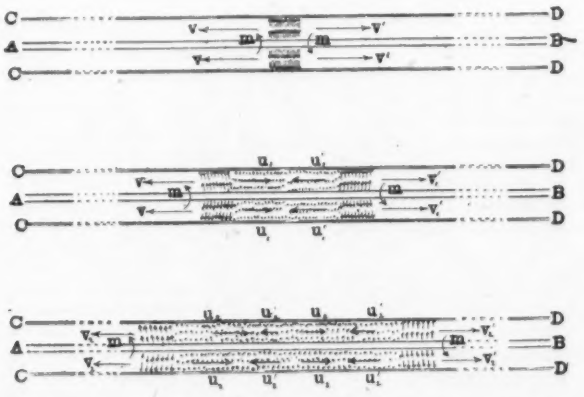
The fact of imperfect conduction may be represented roughly by supposing that the flux instead of slipping freely along the surface of the conductor becomes entangled in the surface of the same, and friction between the parts of the moving flux and the surface of the wire detaches some of the flux and leaves the de-



FIGS. 13, 14 AND 15.

tritus in the pathway. Fig. 18 represents the condition of attenuation at a later stage. Here the original meter blocks have diminished considerably in density and in their stock of energy, their motion being indicated by the arrows v_2 and v'_2. u_2 and u'_2 are arrows representing the motion of the straggling flux or tails, as they have been called, thrown off by the advancing blocks. After a certain distance has been traversed by these blocks they become completely absorbed and the tails only remain, the subsequent motion being very complex. We cannot attain in practice to the distortionless transmission of electromagnetic waves as are represented in the preceding figures. It is, however, possible to so unite imperfect insulation and imperfect conduction; i. e., leakage with conductor-resistance as long as the tailings due to leakage exactly annul the tailings due to conductor-resistance. A circuit in which the leakage and conductor-resistance are so balanced as to leave no tailings is called a distortionless circuit, and no other means of obtaining a distortionless circuit is known at the present time. Although such a circuit is distortionless as the blocks of flux move on without leaving stragglers, yet energy is expended both into the insulator and into the conductor, and consequently, the fluxes diminish in density and attenuation goes on.

The authors next considered what takes place when an electric source such as a dynamo or battery is connected between the wires



FIGS. 16, 17 AND 18.

at one end of the circuit. According to these views, the electric current, which is electric flux rush, is invariably transmitted with the velocity of light in the ether of the particular insulator considered. But the actual velocity with which an electric impulse travels along the circuit as measured by the time which elapses between the action of a source at the generating end and the appearance of energy at the receiving end, always tends to be less than this velocity, because, owing to attenuation and distortion, the first impulse or block of flux may be completely absorbed or dissipated before it can reach the distant end with the velocity with which it travels, and further flux must gradually come up from the source and suffer attenuation and distortion before the vanguard can finally arrive at the receiving end to perform its allotted function. It is for this reason that a sub-marine electric cable between, say Ireland and America, takes nearly one-seventh of a second before an electric signal or impulse transmitted from one end will make its appearance at the other, although the time that an electric wave would take to traverse this length would be only, say, one-sixteenth of a second. The original impulse traveled so far as it went with the velocity of light in the ether of gutta percha, but the vanguard was completely dissipated, and the successive vanguards were attenuated with complete dissipation for a comparatively long time before the distant end could be reached.

It is only on long circuits such as are afforded by telegraph and telephone wires or by submarine cables, that the time of electric transmission with attendant distortion and attenuation are most clearly evidenced. In the comparatively short circuits employed for the transmission of electric light and power, the phenomena

FIG. 19.

of distortion and attenuation of electric and magnetic flux are of little practical importance. Fig. 19 represents the signal sent over the last-laid Atlantic cable, and the corresponding signals, which were received at the distant end. The two should be exact facsimiles, and should, therefore, be capable of actual super-position if no distortion occurred in the electric impulse. Not only the delay or retardation in the received signal, but also the great distortion which is noticeable, are due entirely to the fact that there is very little leakage in the insulator, while there is very appreciable resistance in the conductor. This cable, laid in 1884, has a length of 1847.5 nautical miles. The copper conductor offers a resistance of 1.68 or about 1⅔ ohms per nautical mile, while the insulator has a resistance of 85,000,000,000 ohms in each nautical mile. This cable has a working speed of 45 words per minute, which is much faster than any previously laid Atlantic cable, owing to the greater conductance of the circuit. This cable, of course, possesses enormous distortion, although such distortion does not prevent signals being read until a speed of over 225 letters per minute is attained. If, however, the insulation, instead of being 85,000,000,000 ohms in each nautical mile, were reduced to about 500 ohms in the nautical mile, the leakage trailings would probably balance the trailings due to imperfect conductance, and the cable would be distortionless. The signals, received, therefore, would be the exact counterpart of the signals sent, and an indefinitely high speed of signaling should be possible. With respect to absence from distortion, such an Atlantic cable would transmit telephonic speech waves perfectly. They would, however, possess so much leakage that the received signals would be far too attenuated and feeble to perceive. The conductor would only offer at the sending end a resistance, of approximately 28 ohms, instead of 3108 ohms, the total conductor resistance, and the current strength which would flow from the receiving end to the ground would be, approximately, 5×10^{47} times less than the current entering at the generating end. No telegraphic or telephonic instrument at the present time could detect so feeble a current as this. Moreover, if any accident happened to such a cable, it would be impossible to localize the position of the fault, unless the same occurred within a mile or two from either end. Consequently, the distortionless circuit does not provide at the present time a practical solution for trans-Atlantic telephony.

About 100 miles is, probably, the limiting length of this particular cable, with its good insulation, over which telephonic speech can be carried.

We have not considered the mechanism whereby the electric and magnetic flux is absorbed, and the energy utilized for the performance of any kind of work, such as the operation of a motor, production of signals, or of articulate speech. The wires do for the electric wave what a reflector does for the searchlight; namely, localizes and concentrates the beam into a single path where it may be transmitted to the desired point with the minimum attendant loss in transmission.

DIGEST OF CURRENT TECHNICAL ELECTRICAL ARTICLES COMPILED FROM FOREIGN AND AMERICAN JOURNALS BY CARL HERING

DYNAMOS, MOTORS AND TRANSFORMERS.

Relative Size, Weight and Price of Dynamos. WILSON. Lond. *Elec. Rev.* and *Elec. Eng.*, March 5.—A reprint of a recent paper with numerous curves and tables. He uses as a basis of calculation a figure which he calls a "mass factor," obtained by dividing the output in watts by the revolutions per minute, and deduces numerous curves, with the mass factor as the abscissas and the weight and price as ordinates; in one curve he compares it with the diameter of the armature, showing that this tends toward a maximum; tables are given, showing the speed, mass factor, weight and price for machines of twelve different kinds, and in each case for a number of different outputs; the curves all have a general similarity; they refer to English machines, and represent the latest practice; they show that the weight increases somewhat rapidly as the mass factor increases, and then develops into a thoroughly straight line; in regard to price, the initial increase is very marked; sufficient data could not be obtained to show definitely the point where multi-polar dynamos began to be lighter and cheaper than the two-pole machines. For alternators the mass factor is equally useful, and is independent of the frequency if equal armature reactions are assumed; curves and tables for five different makes of alternators are given, and refer to single phase machines without exciters; the initial rise is greater for the price than for the weight, and the difference in the cost is more marked than for continuous current machines; with regard to weight, the two kinds are about equal up to a mass factor of 100 to 120, beyond which the alternators are somewhat heavier; in price they are, in general, more expensive. In the discussion Prof. S. P. Thompson questioned whether the mass factor was the best basis of comparison, and recommended the peripheral velocity instead, as the voltage depended on the linear velocity, and not on the angular velocity; the output increases in proportion to the square of the linear velocity; he thinks progress tends in the direction pointed out some years ago by Sayers, in which the demagnetizing effect of the armature, or a compensation of it, was provided for; the question of efficiency was not considered by Wilson. Ravenshaw criticised the basis of the curves. Mavor suggested to use the prime cost instead of the list price. Wilson thinks that the same curves for three-phase machines would show that they were lighter and cheaper than those for direct currents.

Calculation of Dynamos. GIRAULT. *L'Ind. Elec.*, Feb. 25.—An article of some length devoted chiefly to the calculation of the density of the current in the armature-wire and pointing out the importance of this factor. In an installation of a known output, in which the dynamo is the only unknown quantity and the time period is a year, the price depends on a constant quantity in the form of the interest and amortisation on the parts not including the generators, and on a variable quantity depending on the choice of the generators; analytically he obtains the quantity for the minimum price; a curve of the price of a dynamo of a given power, as a function of the efficiency, has maximums at zero and 100, and a minimum point rather nearer the zero point, corresponding to a very low efficiency; the practical values are between this and the 100 per cent. efficiency; from this and the formula it follows that the price of a dynamo varies in the direct ratio of the annual duration of the time during which it is used, and with the specific cost of the mechanical energy, and it varies inversely as the rate of interest and the amortisation; the principal factor is the time during which it is used; if this time is very short the cost price of the dynamo should be low; in constructing the dynamos for the lowest cost, the different elements of the armature should be determined, having given among other things the diameter of the wire of the armature or what amounts to the same thing, the density of current; this he discusses analytically at some length, limiting himself to armatures without teeth and to circular wires; he obtains equations for the minimum diameter of the armature and for the diameter of the wire, but the value for the latter gives a current density which is much too great to be used in practice; he shows that a dynamo is less voluminous and therefore lighter as the diameter of the wire is finer; it is, therefore, very important, especially for small machines, to know what the maximum density is that can be used; this can only be determined empirically; it is often stated that the maximum density is 400 amperes per sq. cm., but this is too vague, as, in practice, it is from 150 for large dynamos to as high as 800 for fine wires. He gives a numerical example and shows that the cost of the dynamo is quite approximately proportional to the cube of the diameter of the dynamo, but it increases relatively more rapidly for high current densities; the minimum cost as a function of the density of the current corresponds to a value of this density quite different from that corresponding to the minimum dimensions. The formulas are applied to all the different kinds of armatures and motors.

Theory of Constant Speed Direct Current Motors. JOYCE. Lond. *Elec. Rev.*, March 12.—A criticism of the paper of Rhodes, (see *Digest*, last week.) He thinks the statements are likely to prove misleading to those not practically conversant with motor designs; it is not correct to assume that the reluctance of a magnetic circuit is a constant; he gives the formulas which he uses when designing motors, both for the long shunt and for the short shunt. This is followed by a communication from a student showing that the amount of series wire must be reduced instead of increased, by an amount equivalent to the opposing armature-field. In a reply by Rhodes he admits the correction for armature reactions and shows how this changes his equations. Regarding the constant magnetic reluctance, he states that the changes in reluctance will not be great enough to render useless such calculations as are based on the assumption that it is constant.

Dynamo Construction. SEIDENER. *Zeit. Jeur Elek.*, March 1.—A reprint of a short lecture, in which he describes how he calculates a dynamo, and gives some of the results of his experience in their construction, with special reference to the use of steel in the place of cast iron for the smaller dynamos.

LIGHTS AND LIGHTING.

Train Lighting in Austria. KRIZ. *Elek. Zeit.*, March 4.—An illustrated description of the system of lighting used on the postal cars in Austria; the Boese accumulators are used; the complete installations on the cars are shown; the accumulators are charged at one of the end stations; the system is successful in every way.

Enclosed Arc Lights.—L'Ind. Elec., Feb. 25; translated in the Lond. *Elec. Rev.*, March 5.—An abstract of a recent paper by Pierron giving the results of tests with the Jandus lamp; the results are said to be of special interest because the tests were made in an absolutely impartial manner.

Arc Lamp.—Lond. *Elec. Rev.*, March 12.—A description of the Blahnik arc lamp, in which both carbons move and are operated by means of a brake.

Voltaic Arc.—West. Elec, March 20; an abstract of an article from the *Wied. Ann.*, (no author's name nor further reference is given.)—The writer states that after deducting the counter electromotive force there is little difference whether the electrodes are of carbon or of metal, and that this is true for the continuous current, but not for the alternating; the heat conductivity of carbon is less; metals disengage their own vapor, while carbon throws off a gas which remains as a conductor; oxidation plays an important part in the arc; the voltage and length of arcs between carbon and the various metals are given, showing that, as a rule, the voltage is greater when the carbon is the cathode than when it is the anode.

Electric Ship Lighting. BERNARD. *Cassier's Mag.*, Feb.—A description of the plants which he recently installed on several steamers, with special reference to the wiring and methods of distribution, including illustrations of the switchboard connections; he calls it a composite system, the wires being run in iron conduits thoroughly insulated on the inside.

Arc Lamps.—West. Elec., March 20.—Well illustrated descriptions taken from a foreign paper, of three different types of foreign arc lamps, the first being a differential lamp, with no mechanical regulation; the second containing no clock work, and the third having a ribbon brake.

POWER.

12,000 Volt Continuous Current Transmission Plant.—Elek. Anz., Feb. 21.—A brief description of the plant at Steinamanger, Hungary, which, when completed, will transmit 1200 horse-power by means of a continuous current of 12,000 volts, which is claimed to be higher than that of any other continuous current plant. The primary station is at Ikervar, where there are now three turbines of 300 horse-power each, to which two others will be added, one of which is a reserve; there are six Thury continuous current dynamos of 1500 volts and 65 amperes each in series, two of which are connected to each turbine; there is a switchboard for each group having a voltmeter, an amperemeter and a short-circuiting switch; each dynamo has a separate short-circuiting switch to cut it out as soon as it acts as a motor; the dynamos are regulated by hand by adjusting the speed of the turbine; the line is a single bare copper wire, 38.4 miles long, the loss on which is 10 per cent. There are a number of transformer stations at different places along the route, each of which consists of a high-tension motor connected with a generator; each of these motors is provided with an automatic speed regulator and an automatic cut-out, which short-circuits the motor as soon as a dangerous speed is reached.

Electrical Energy for Farming.—L'Energie Elec., March 1.—An article giving an illustrated description of a plant on a private farm near the village of Enguibaud, near Toulouse, France, which has been referred to before in these columns. The current is obtained from a 30-hp water power some distance from the farm; a brief description of the plant, with illustrations, is given. The principal application seems to be for plowing, and it appears that this is done by means of a sort of electrically operated windlass, which draws the plow by means of a cable, the plow being attached alternately to the outgoing and to the return cable. The description is not very clear, but further details are promised in the next number of that journal, in which are to be included the costs of operation.

Electricity in Agriculture. MCGHIE. *Cassier's Mag.*, Feb.—After giving a historical summary, beginning with the year 1783, he describes the more recent application, including the tests of Bailey and a number of illustrated descriptions of electrically operated plows.

TRACTION.

Accumulator vs. Trolley Traction. RASCH and BIRNBAUM. *Elek. Anz.*, Feb. 14.—Reprints of two articles, one by the former author in favor of accumulator traction and the second by the latter against it; most of the statements and arguments are already well known. After giving the usual well-known advantages of the accumulator system, Rasch discusses the disadvantages, which are the gradual failure of the positive plates and the great weight; he admits the former, but states that a solution of this problem has nearly been reached; in Hanover, for instance, accumulator cars have now been running for fourteen months, during which time 3 per cent. of the plates have become useless, that is about 2.5 per cent. per year; as more will deteriorate during the following years, he takes five times this number, which will be 12.5 per cent., which means that each accumulator would become useless in eight years, requiring the setting aside of a fund of 11 per cent. of the cost price, which, added to the 4 per cent. interest and other repairs, makes about 18 per cent.; he makes similar calculations for the trolley and the conduit systems, and obtains the figure 640 marks for the overhead line, corresponding to about 8 per cent. of the investment; 5600 marks for the conduit system, corresponding to about 8 per cent., and 1800 marks for the accumulator system, corresponding to 18 per cent.; these costs are only a small portion of the total per car mile, and therefore the relatively larger difference is really only a small amount in the total; he admits that the cost of operating the trolley systems is cheaper. The effect of the increased weight is only quite small when the additional power required to move this weight is calculated. In the article by Birnbaum he states that accumulator traction is limited to grades not exceeding 5 per cent.; almost everywhere the first cost of accumulator lines will be greater than for the overhead lines; he gives the cost of a battery for each car as $1000; for ten minute intervals the cost of the plant is about the same for both, but the cost of operation is much greater for the accumulator, on account of the greater amount of power required, due to the efficiency and weight of the accumulators; the maintenance of the accumulator costs about $100 per year per car; the cost of operation is about one-third greater.

Accumulator Traction at Ostende.—L'Elec., Feb. 27.—A note stating that six miles of accumulator lines are to be constructed in that city for the coming season; the cars are to carry fifty passengers and are to have two motors; they will be capable of drawing a trailer; the weight of the accumulators is 6600 pounds; there will be 108 cells; the voltage is to be 220.

Simplex Conduit System.—Lond. *Elec. Eng.* and *Elec. Rev.*, March 12.—An illustrated description (much more complete in the former journal). The chief feature is the use of a flexible conductor, which is supported at intervals, like an overhead conductor, thus leading to a system which is thought by the latter journal to be the simplest yet devised and remarkably free from mechanical weaknesses. The conduit is quite narrow, and is built of concrete; it is under one of the rails, the slot being the space between two rails; the insulators are under small removable lids, enabling each one of them to be readily examined and permitting the drawing in and out of a new conductor if necessary; the conductor simply rests on the insulators, and at every quarter of a mile, or turn or crossing, there is a special straining gear, which is an important feature of the system.

Surface Contact System.—L'Eclairage Elec., Feb. 27.—A brief illustrated description of the Lacroix system, in which there is a contact block above a small box containing the necessary switching apparatus, which is operated by the car passing over it.

Electricity on Steam Roads. CLARK. *St. Ry. Rev.*, March 15.—A reprint in part, of a recent address before the Railroad Committee of Connecticut describing some of the experiences on the Nantasket Beach line, where electricity superseded steam, and speaking very favorably of the third-rail system; referring to lines competitive with steam lines, he remarks that "they cannot long prosper when the day comes to lay down third rails in this country"; he believes that where there is sufficient volume of business the electrical system is undoubtedly practicable and profitable for steam roads.

Switching Locomotives. MULLIN. *Cassier's Mag.*, Feb.—An illustrated description of the 30-ton electric switching locomotive used on a private line at New Haven. Among other things it is stated that a striking thing about the behavior of it is the certainty with which it can be moved over short distances varying from a few inches to a few feet, thereby saving a full third of the time occupied by steam switching locomotives.

Columbia and Maryland Railway. HUFF. *St. Ry. Rev.*, March 15.—The beginning of an article describing a number of plans and suggestions which were considered in the construction of this line, which is said to be the first of its type, combining long runs, high speeds, heavy trains and severe grades; the road will extend from the centre of Baltimore to the centre of Washington; a number of problems had to be carefully considered.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Charging for Electricity. WILSON. Lond. *Elec. Rev.* and *Elec. Eng.*, March 12.—The beginning of a reprint of a paper before the Northern Society of Electrical Engineers. He enumerates the different systems at present in use and criticises each of them; he contends that Hopkinson's system is fundamentally correct; he speaks very favorably of the Wright system, which leaves little to be desired; it has, however, a defect apart from its complication and expense, which is that the spirit of the method has to be departed from because the indicated demands are not all simultaneous; Andrews at Hastings uses this system, but instead of a charge of so much per unit of maximum demand for the first hour, he charges 25 cents per 8cp lamps used simultaneously per quarter and 12 cents per unit consumed; this produces a tendency to turn on as few lamps simultaneously as possible, but Wright's criticism of this is that it would tend to decrease the number of lamps installed; Andrews has not found this to be the case; it is much easier to explain this method to the consumer. Another drawback to the Wright system is that an abnormal maximum may be indicated when a large number of lights is used for any one evening, but in that case special arrangements are made. He then begins to describe what he considers by far the most satisfactory principle, namely, the differential rates based upon the time of day; the time rates are thus based on the actual output of the station as a whole; those who contribute least to the peak should benefit most largely by the system of discounts; a consumer whose maximum demand is in the early morning should not pay as much as one whose maximum demand is during the heavy load period; he favors Kapp's system, in which a time switch is used in connection with the meter, by which current used at certain times is charged for at reduced rate. The question is editorially discussed in the London *Elec.* March 12; the pure theory of charging is given and its bearing on practice pointed out; it is thought that the discussion of possible methods of charging is being a little overdone.

WIRES, WIRING AND CONDUITS.

Rise in Voltage on Three-Wire Circuits. WASKOWSKY. *Elec. Anz.*, Feb. 21.—It is generally supposed that in a three-wire system, with accumulators as the source, the voltage cannot exceed the normal, supposing the regulation to be perfect; in the present article he shows that this is not true; with the aid of simple algebra he shows that the loss of voltage occurring at the largest load can become much greater with small loads, if the loss is not divided equally on the two halves; for calculating the voltage, the formula given in text books is frequently used, but he shows that this is not correct; the usual method for calculating the voltage at the lamps also gives incorrect results; in one case he found that the voltage at the ends of the line was higher than at the feeding points; this is theoretically correct; he shows that such cases can arise in installations in which the balancing of the two wires is determined by readings of ampere meters; these readings do not even show approximately whether the two circuits are balanced; a check with a voltmeter is necessary. There is another cause for a rise in voltage in single lamps; the cause is that of a three-wire system or any portion of it in which the two halves are not equally loaded, and in which the fuse in the neutral wire blows, a case which is quite possible.

Prevention of Fires due to Leakage of Electricity. BATHHURST. Lond. *Elec.*, March 12.—A reprint of a Society of Arts paper for which the Fothergill prize has been awarded. He discusses the subject of wiring, insulation and the cause of fires, leading to the conclusion that an insulating tube system fully meets the conditions; the reprint is followed by the discussion.

ELECTRO-PHYSICS AND MAGNETISM.

Work of the Reichsanstalt.—Lond. *Engineering*, Feb. 26 and March 5.—An abstract of a report of this institution for the year ending Feb., 1896; it appears to be taken from an official abstract in the *Zeit. f. Instrumentenkunde.* The work covers a wide range of subjects, among which are the following which are of interest to the electrical engineer; some have already been noticed in these columns. Regarding standard resistances, favorable results have been obtained in making repeated tests of the primary and secondary mercury and manganin standards; from these results it has been concluded to use manganin standards for comparison, for which they are far more convenient than the secondary mercury standards; a list of some of the particulars of a few new resistance materials is given, showing their constitution, temperature coefficient, thermo-electric force against copper and their specific resistance. The E. M. F. of the normal cadmium cells has been ascertained by a great number of measurements; at a temperature of 15 or 20°C it is 1.019 volts; the amalgam contains 16.7 parts of cadmium and 100 of mercury; an amalgam of 1.2 per cent. of cadmium yields an E. M. F. of almost exactly one volt, but the temperature coefficient is higher. The determinations made with silver voltameters have shown that basic silver solutions give a larger silver deposit than perfectly neutral nitrate, and that the platinum leads must not come in contact with the liquid, as otherwise silver peroxide is formed and too little silver is deposited. The d'Arsonval galvanometer is discussed as an instrument which is protected from electrical disturbances; while in many respects they are splendid instruments, they crawl when used with small resistances and are insufficiently damped if high resistances are in circuit; their sensitiveness can be increased to almost any degree, but the time they require before equilibrium is obtained grows likewise; these galvanometers, therefore, have a very limited range of applicability. Magnetic tests of iron and steel are referred to; they were concerned chiefly with an investigation of the homogeneity, and have already been reported in these columns. The effect of electric railways on physical institutes is discussed at some length. The platinum unit of light devised by Lummer and Kurlbaum is described; it differs from the Violle standard in that the radiation is taken at a given temperature. In investigating the subject of pure zinc it was found that electrolytic zinc from zinc sulphate, which should be kept neutral or basic with ammonia or zinc oxide, contained platinum and was very soluble in sulphuric acid, contrary to what is usually stated; Lorenz found that the electrolysis of fused zinc chloride with carbon electrodes offers a more convenient way

of preparing pure zinc. Cadmium may be refined electrolytically; to test whether any zinc is present the fused, slightly overheated metal is touched with a glass rod, which at once ought to appear colored; 0.01 per cent. of zinc will prevent discoloration.

Resistivity of Bismuth. Dewar and Fleming. Lond. *Elec.*, March 12; a report of a Royal Society paper.—They give the results in the form of tables and curves, of carefully made measurements of electrical resistivities of electrolytic bismuth at low temperatures and in magnetic fields; the temperature was as low as -203°C. and the magnetic field as high as 22,000 units; the resistivity is given for each temperature and for various transverse fields. The observations lead to the conclusions that if the transverse field is zero, then cooling the bismuth always reduces its resistance; if the transverse magnetism is then increased the resistance increases, and for every temperature there is some particular field which just annuls the effect of the cooling; the lower the temperature the less the strength of field, which will bring the bismuth back to its original resistance, which it had not when not cooled and not in the field; the curves show how remarkably the resistance is affected by the magnetism; in liquid air and in a field of 22,000 units the resistance due to the field is 150 times greater; the lower the temperature the greater the multiplying power of a given field; at absolute zero bismuth should lose its resistivity like other metals, but it should be converted into a non-conductor at that temperature by a sufficiently strong transverse field; in this respect this metal is a remarkable exception to other metals; very small amounts of impurities reduces these remarkable qualities considerably. Other curves show that when placed in a certain magnetic field there is a temperature at which bismuth has a minimum resistivity, and therefore a zero temperature coefficient, and that the temperature at this turning point is higher the stronger the transverse field.

Temperature of the Arc. Guillaume. *L'Eclairage Elec.*, Feb. 27.—An abstract of a discussion at the French Physical Society in which he offers an explanation of the constancy of the temperature of the positive carbon. He suggests that the carbon is dissolved in the surrounding air, as certain soluble substances are dissolved directly in compressed gases; this dissolution takes place at a temperature which is lower, the higher the external pressure. This would explain the apparent transportation of the carbon which condenses on the negative electrode; this might lead one to suppose that under high pressure this condensation might result in the formation of diamonds.

Voltages for Discharges from Points. Wesendonck. *Weid. Ann.*, 60, p. 209; abstracted briefly in the *Elek. Zeit.*, March 4.—He describes experiments to determine the voltage at which discharge between points in air and hydrogen begins. In air, negative electricity starts from a point at a lower voltage than positive, but is subjected to much greater variations; in hydrogen the voltages are lower than in air and there is no difference in the positive and negative discharge voltage, but from points more electricity escapes from the negative than from the positive; in all of these experiments one terminal was a plate, while the other was a point.

Electric Discharge Through Electrolytes. Cardani. *Nuovo Cimento*, 4, p. 200; noticed briefly in the *Proc. Lond. Phys. Soc.*, March.—He passed Leyden jars discharges through an electrolyte, assuming that alternating currents are produced therein, and concludes that electrolytes do not behave like metallic conductors. (The abstractor in the latter journal intimates that the author was not dealing with alternating currents at high frequency.)

Thermo-Electric Currents in Molten Metals. Backhmetieff and Stambolieff. *Trans. Russian Physico-Chemical Society*, No. 29; noticed briefly in the Lond. *Elec.*, March 5.—They found that the intensity of the currents depend on the temperature and the position of the electrodes with respect to the direction of the earth's magnetic field, the current being a maximum when the line joining the electrodes lies in that direction; as the metal cools the current passes through a series of periodical changes of intensity and direction. In another paper, by the same authors, they deal with currents in wires previously heated by the current and allowed to cool; they found that the current is always the reverse of the current which produced the heating, thus showing that the Joule effect appears to be reversible; it is confined to the magnetic metals and depends on the direction of the field in which they are placed; the effect dies away after several repetitions.

An Action of Induction Currents. Meyer. *Elek. Anz.*, Feb. 21.—A short article describing the following observation. He was measuring the resistance of a liquid by the Kohlrausch method, which involves the use of alternating currents produced in an induction coil; when he brought the telephone near to the coil, but without any metallic connection with it, the diaphragm began to vibrate, giving a decidedly audible note, due to true acoustic resonance; the proof that it was pure resonance was shown by the fact that the circuit of the telephone was open, and that when it was closed the note ceased; the explanation of this is that currents were then generated in the circuit by the vibrating diaphragm, which therefore had to do sufficient work to stop it.

Electrolytic Conductivity of Solids. Fritsch. *Wied. Ann.*, 300; abstracted in the *Zeit. f. Electrochemie*, Feb. 20, and *Elek. Zeit.*, March 4.—The article treats of the changes in the conductivity of pure salts caused by small additions of other salts (forming solid solutions); also their temperature co-efficients.

Notes on Zeeman's Discovery. Lodge. Lond. *Elec.*, March 12.—An article in which he makes some corrections in his previous paper, (see *Digest*, last week) and points out an important discrepancy in one of the numerical values, offering an explanation of it.

Influence of Vibration on the Resistance. Murani. *Beiblaetter*, 6, p. 561; abstracted in the *Jour. Inst. Elec. Eng.*, March.—He describes experiments in which he finds that transverse vibrations exert very little influence on the resistance of a wire.

Electro-Physics. de Heen. A number of papers noticed briefly in the Lond. *Elec.*, March 12.—In one from the *Comptes Rendus*, No. 9, he states that he has obtained the shadow of a cross from the anode or cathode at will but with variations as to size. In another paper in the same journal he describes a way of photographing the electric radiations of the sun. In the *Bulletin of the Belgian Academy*, No. 12, there are two other papers by the same author, one on the infinite variety of electrical energy in which he claims that the charges of the Holtz machine are always negative with reference to those derived from a Ramsden machine; the other paper deals with Zenger's electrical dynamical world system; he maintains that static charges are due to transverse ether vibrations, and that cyclones are of electrical origin.

Electric Discharge and Photographic Action by Röntgen Rays. Donati. *Proc. Lond. Phys. Soc.*, February; abstracted from the *Nuovo Cimento*, 4, page 164.—He describes experiments, from which he concludes that there is a constant ratio between the action on the electroscope and the photographic action.

Power of Fluorescent Screens. Salvioni. *Nuovo Cimento*, January; noticed briefly in the Lond. *Elec.*, March 5.—He describes an attempt to compare two X-ray screens with regard to their cryptoscopic power, based on the sine law of reflection, which is found to be rigidly true; he found that the fluorescence depended only on the amount of energy received, and not on the angle of incidence.

Röntgen Rays and Water Vapor. Richarz. *Proc. Lond. Phys. Soc.*, February; a mention of a paper from the *Wied. Ann.*, 59, p. 592.—He shows that Rontgen rays decompose water vapor into ions, the presence of which causes the formation of a fog.

Cathode Rays and Jaumann's Theory. Poincare. *Proc. Lond. Phys. Soc.*, February.—A long abstract of the article in *L'Eclairage Elec.*, p. 241 and 289, 1896, which was noticed some time ago in these columns.

Improved Röntgen Tube.—Lond. *Elec. Rev.*, March 5.—A translation in abstract of the article, by Berliner, noticed in the *Digest*, March 6.

Fluorescence of Uranium. Spies. *Proc. Lond. Phys. Soc.*, February; abstracted from the *Ver. Phys. Ges.*, Berlin, 15, p. 101.—The radiation from uranium does not produce a visible fluorescence, but it can be detected by laying a piece of bromide paper on some fluor-spar and laying the uranium above this; a lead plate stops the radiations.

New Kind of Black Rays. Friedrich. *Elec. Anz.*, Feb. 18.—Some further statements regarding these rays and their bearing on his new ether theory.

ELECTRO-CHEMISTRY AND BATTERIES.

Cyanides for Electric Batteries and Accumulators. Platner. *Electrochem. Zeit.*, March.—The first part of an article in which he discusses the application of such compounds; the strong tendency of cyanogen to combine with most of the metals, and also the ease with which the metals are deposited from the double cyanides, suggests their use in batteries; one difficulty lies in the tendency of such compounds to decompose; he therefore limits himself to the composite cyanogen compounds to which this objection does not apply. Commercial salts of the combination of iron, cyanogen and alkalies contain an excess of alkali, which should first be removed; this can be done by the addition of Turnbull's blue; a zinc plate may then be placed in this solution and depolarization may be produced by Turnbull's blue and a chemical rich in oxygen; in this way the ferricyanide of potassium which acts as the exciting fluid is regenerated, and is therefore maintained constantly; such an element is specially suited for dry cells; the regeneration of hydrogen is so completely stopped that such a cell may be quite safely sealed completely; the E. M. F. is 1.6 volts. Cyanide accumulators will be discussed in the next article.

Alkaline Phosphate and Caustic Alkali—Lond. *Elec. Rev.*, March 12.—A note stating that at Biebrich-on-the-Rhine these materials are now being made electrolytically; concentrated solutions of phosphoric acid and of a soluble alkali salt, such as sodium nitrate, chloride, or sulphate, separated by a suitable diaphragm in an electrolytic cell, are electrolyzed to obtain in the anode compartment nitric or sulphuric acid or chlorine, as the case may be; and in the cathode compartment either a mono-, di-, or trisodium orthophosphate. The process may be interrupted at the proper time to obtain any one of these salts; a carbon anode and a lead cathode are preferably employed; when nitric acid or chlorine is produced it may be recovered by heating the solution; to obtain a caustic alkali the sodium or potassium phosphate, obtained as described, is treated with caustic lime, calcium phosphate being produced as a by-product.

Formation of Ammonia from the Electrolysis of Nitric Acid.—Zeit. f. Physik u. Chem.; abstracted in the *Jour. Inst. Elec. Eng.*, March.—In the continued electrolysis of nitric acid, uncombined nitrogen finally remains, which either escapes as such, or if sufficient hydrogen is present combines to form ammonia; he finds that the oxidizing power increases with the concentration, while the reducing power of the hydrogen at the cathode increases with the current density; consequently, by raising the current density a stronger or weaker reducing action may be obtained as desired.

Effect of Manganese Compounds in the Lead Accumulator Knorre. *Zeit. f. Elektrochemie*, Feb. 20.—An article in which he calls attention to a number of patents in which manganese compounds are used in connection with the lead accumulator, and he shows that manganese compounds, whether

as peroxide on the positive plate or in solution, acts as a carrier of oxygen from the positive to the negative plate, and therefore acts to discharge the accumulator, thus reducing the capacity. The action of the peroxide of lead on the sulphate of manganese in the solution is to reduce the permanganic acid; the same takes place if the peroxide of manganese is contained on the positive plate; the result is shown by the characteristic color of the solution; the spongy lead acts as a reducer of the permanganic acid. He concludes that every trace of manganese compounds is to be avoided in lead accumulators.

Production of Electrical Energy from Gases. ANDREAS. Lond. *Elec. Rev.*, March 12.—A note concerning an article by that author from the *Zeit. f. Elektrochemie*, Vol. 3, p. 186, in which he investigated the action of batteries depending on the oxidation of hydrogen, carbon monoxide, etc.; together with Borchers, he found the weak point in such batteries; this appears to be in the electrodes, which become dissolved as the battery acts; they conclude that success with such batteries can be secured only by discovering an electrode which does not pass into solution during the oxidation of the gas used in the battery.

Electrolytic Researches with Chlorine and Sulphur. GROSS. *Zeit. f. Electrochemie*, Feb. 20.—A short note stating that by electrolyzing molten silver chloride and sulphide between platinum plates, free from iridium and protected from the action of air, a new dark substance was obtained which could not be decomposed, was infusible, very resistant towards acids and easily separated from platinum and all other substances.

Alkalies and Chlorine. STOERMER. *Zeit. f. Elektrochemie*, Feb. 20.—A description of an interesting observation in connection with mercury cathodes; he found that the surface of the mercury formed a sort of skin, which may be made to remain at rest while the mercury beneath is maintained in motion; the tendency of the surface to decompose water diminishes as the power of absorption of the lower layers of the amalgam increases; several forms of apparatus for accomplishing this are described and illustrated.

Bleaching Solutions.—L'Elec., Feb. 27.—A short article on the Kellner system which is specially adapted to bleaching; the ordinary lighting currents may be used and the cost of installation is very small; the electrodes are made of plates of hard rubber, having a large number of projections of platinum wire resembling a brush, which enables a very large current density to be used; the liquid enters between the plates at the bottom and passes out at the top, after which it is cooled and passed through again as many times as is necessary for the desired amount of chlorine; in one passage the amount of active chlorine which is formed is 0.05 per cent.; the refrigerating apparatus forms an important part of the system; the repetition of the action is continued until the solution contains 1.5 per cent. of chlorine.

Bleaching. KELLNER. *Zeit. für Elek.*, Feb. 15.—A continuation of the illustrated abstracts of his patents.

Electrolytic Preparation of Percarbonates.—Elek. Anz., March 4.—A summary of the recent work of Elbs, Schoenherr and Kuester.

Haemoglobin or Blood Cell.—Elec. Eng., March 17.—An anonymous communication referring to the recent experiments of Case, and suggesting to those who make researches in this direction the utility of studying the work of Matteucci, De la Rive and others in the same field, particularly the work of the former, which is quoted from. He also calls attention to what appears to be a broad, fundamental patent of Case, 368,190, 1887, which, from the claims quoted, appears to cover the field of converting chemical into electrical energy by chemically attacking or oxidizing carbon in a galvanic cell without the application of heat.

Application of the Cyanide Process in South Africa. BUTTERS. *Eng. & Min. Jour.*, Mar. 6.—An abstract of a recent lecture at the University of California.

Storage Battery and Engineering Practice. APPLETON. *Elec. Eng.*, March 17.—The first of a series of articles. The present portion is introductory in character, giving the chief principles, but containing nothing new. He remarks, among other things, that there are storage battery plants in the United States "which excel those in Europe, both as regards magnitude and method of installation."

Electro-Chemical Laboratory.—West. Elec., March 20.—A very brief illustrated description of the equipment of such a laboratory at the University of Wisconsin, which institution is claimed to have taken the initiative of the engineering schools in providing for training in electrochemistry.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Measurement of Resistance of Electrolytes. WIEN. *Proc. Lond. Phys. Soc.*, February; abstracted from the *Wied. Ann.*, 59, p. 267.—He reviews at length the points in his recent dispute with Kohlrausch and summarizes them as follows: The influence of polarization upon Kohlrausch's measurements with the dynamometer gives rise to an error which is generally very small as compared with the true resistance of the fluid cell; the maximum error as found in the lower resistances may reach, with large electrodes 1.4 per thousand; with smaller ones, 6 per thousand; these values must be considered to be only approximate because of the great variability of polarization in platinized electrodes; the author considers that in most of Kohlrausch's experiments the polarization was considerably greater than in his own; these errors are confined to the older measurements of Kohlrausch, made with the dynamometer; and even here they are only just perceptible in a few out of hundreds of observations.

Direct Reading Fault Localizer. RAPHAEL. Lond. *Elec.*, March 12.—A description of a modified slide wire bridge, making the method more convenient to use. The principle is that of the Murray loop method, in which there is a stretched wire, which is divided by the battery contact point in the same ratio as the fault divides the cable loop (the usual arrangement); the modification consists in having one end of the cable and the galvanometer connected permanently to the zero end of the slide wire scale, and to arrange the other galvanometer and cable end so that they can be connected with the slide wire at any desired reading of the scale; this reading is so chosen that it numerically represents the length of the cable loop; the point at which the battery connection is made in order to balance will then give the numerical distance of the fault directly; no calculations are therefore required. The complete instrument is described and illustrated with special reference to the contacts with the stretched wire; four different scales are conveniently mounted on a revolving square bar, the lengths of which are divided, respectively, into 1000, 500, 250 and 125 parts, in order that as great a length of the stretched wire as possible may be used for different lengths of cable.

High Voltage Accumulator. ZEHNDER. *Wied. Ann.*, 60, p. 47; abstracted briefly in the *Elek. Zeit.*, Feb. 25; an abstract of the article which was noticed in the *Digest*, Feb. 6.—In addition to what was stated before in this description of how to handle such a battery, the following points may be of interest; the creeping of the acid on to the copper conductors may be prevented by coating the copper wires as well as the upper parts of the lead plates with vaseline; over the acid, which has a density of 19 to 20° B., is poured a layer of 3 to 5 mm deep of paraffine oil, which will keep the cells more uniform, make them retain their charge longer and almost entirely prevent evaporation and spraying; to fill these cells with acid he uses an apparatus which is illustrated in the abstract, the essential feature of which is that in addition to the tube through which the acid flows into the cell there is another tube fastened to it so that the ends are on the same level; the additional tube being connected with an exhaust pump, the object being to prevent the acid from overflowing while the cell is being filled; should the acid exceed a certain height in the cell it will immediately be sucked out through the second tube down to the desired level; with this apparatus the 600 cells of his battery can be filled in about half an hour.

Astatic Galvanometer. BROCA. *Jour. de Physique*, February; noticed briefly in the Lond. *Elec.*, Feb. 26.—He describes an instrument which is said to be absolutely astatic and very sensitive, the novelty of which lies chiefly in the fact that each of the four needles forming the magnetic system is astatic in itself, each one having a consequent pole in the centre; the intensity of magnetization can be as high as 90 per cent. of that of the ordinary needle, and it is practically constant "for several months"; the needle must be quite straight, and they are therefore tempered under longitudinal stress.

Automatic Interruptor for Induction Coils. SAYEN and WILLYOUNG. *West. Elec.*, March 20.—A reprint of the article noticed in the *Digest* March 13.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Telephone Service Without a Calling Battery at the Subscriber's End. RITTER. *Elek. Zeit.*, March 4.—The conclusion of his long article (see *Digest*, March 13); he describes another installation constructed according to this system in Feb., 1896.

Electric Clocks.—L'Elec., March 6.—A translation of the greater part of an article, with illustrations, published some time ago in the *Elek. Zeit.*, by West, describing the installation in the Krupp Works.

Cable Making Machinery. Lond. *Elec.*, *Elec. Rev.* and *Elec. Eng.*, March 12.—An illustrated description of some new machinery designed chiefly to diminish the number of hands required and to increase the speed.

Domestic Telephone System. PIERARD. *L'Elec.*, Feb. 27.—A brief illustrated description of a system in which each of a number of station subscribers can call any of the others without the use of any central station; the illustration shows the arrangement for a system of five stations, and is claimed to be very simple; one of the objections to it is the large number of wires required, which in this case appears to be eight.

Railway Signals. HOLLINS. *Jour. Inst. Elec. Eng.*, March.—A reprint of his complete paper with the discussion.

Marconi's New Telegraph—McClure's Mag., March; reprinted in the *Elec. Rev.*, March 17.—An interview with the inventor, by Dam. The inventor is 22 years old; after a brief description of the co-operation of Mr. Preece, the answers to a number of questions are given which brought forth the following facts. (As stated before in these columns, this is a system of telegraphy without wires by means of waves somewhat similar to those of Hertz.) He found in an early experiment that the waves went through or over a hill three-quarters of a mile thick; Morse signals were transmitted with ease; Hertz waves have but a very limited penetrating power, while the present kind of waves with the same amount of energy seem to penetrate everything; the exact difference between these and the Hertz waves is not known, but he believes it to be in the form of the waves; secrecy is still maintained regarding the construction of the transmitter and receiver; he uses about 250 million waves per second; their range is the same as that of the Hertz waves, but the latter are stopped by metal and water, while the others are not; the exciting energy is the same; the difference is in the way they are excited; the receivers and transmitters will not work with those of Hertz, they being entirely new, but the waves are excited in the same general way; he has sent messages through the air for a distance of 1.75 miles; at two miles the result is not quite satisfactory; eight volts and three amperes were used, together with a reflector, but the latter will be abandoned in the future, as it is of no value; no lens is used, as these waves are neither reflected nor refracted; he believes they can be sent across London through all the houses, it being

merely a question of the size of the apparatus; at present he thinks the practical limit is about twenty miles, but the distance depends simply on the exciting energy and the size of the apparatus; the radiation decreases inversely as the square of the distance, like light; the system can be used in connection with lighthouses in the case of a fog; the transmitter and receiver which were used on Salisbury Plains are about 15 inches by 10 by 8; at present he and Mr. Preece are working at Penarth in Wales between the shore and a lightship; he uses waves from 30 meters down to 10 inches in length; he thinks the method will be used in preventing the collision of ships in a fog; to send a message from London to New York might take an apparatus 20 feet square in the base, but he will not say how high; 50 to 60 horse-power will suffice, and the costs of the two stations will be about $50,000; he does not say whether the waves would go through the earth or the air; at present he sees no way of concentrating the waves to make them go in one direction; one of the first applications will be for military purposes, but for naval purposes there seems to be a danger that the waves, which could explode the powder magazines in other ships, might also explode them on the ship on which the apparatus is.

Electricity on the Cincinnati Southern Railway. Coles. *Elec. Rev.*, March 10.—A short article giving a brief and very general description chiefly of the automatic signalling system on this line. The locomotives of the fast trains are also equipped with electric headlights, the current being furnished by a combined engine and dynamo of 4-hp capacity.

Watson Telephone Patent.—Elec. Jour., March 1.—An article on the recent legal decision against this patent with illustrations taken from the specifications.

Requisites of a Perfect Fire Alarm Box. Johnson. *West. Elec.*, March 20.—A reprint of a short paper read before the Illinois Firemen's Association, in which he points out the importance of having non-interferences in such services so as to prevent absolutely any confusion or loss of signals.

The Condenser. Finn. *Teleg. Age*, March 1.—The conclusion of the very long serial on that subject which has been running through that journal; in the present portion the Marshall system of simultaneous telegraphy and telephony is described with the aid of illustrations.

MISCELLANEOUS.

Italian Electro-Technical Association.—L'Elettricista, January.—A report of the foundation of this association in Milan on Dec. 27.

Production and Application of Ozone. Andreoli. *L'Elec.*, Feb. 27.—A continuation of his paper (see *Digest*, March 13); it is general in character and does not admit of being abstracted. He calls attention to the importance of having dynamos and transformers for high voltages; it is above all the high frequency and not the high tension which is an important factor in the generation of ozone; he discusses the use of insulating materials in ozone generators, which, however, he abandoned when he found that it was a mistake to use plates of a large surface; the great trouble with the silent discharge arises from the heat produced which destroys the ozone; when the apparatus becomes hot it will not suffice to merely stop it for a short time, but it is necessary to cool it completely; in the electrification of air a pernitric acid is formed which the electric discharge decomposes into peroxide of nitrogen and oxygen, and this destroys the ozone; at a low temperature more ozone is formed than at the ordinary temperature; attention is called to the importance of the proper velocity of the gas through the ozonizer.

Exhibition.—Lond. *Elec.*, March 12.—Illustrated description of some of the machinery at the Newcastle-upon-Tyne exhibition.

Duration of Lightning Flashes. Kendrick. *Rose Technic*, March.—An article questioning the fact usually stated that the duration of lightning flashes is on the order of the thousandth of a second; he cites some crude experiments tending to show that the duration is of quite an appreciable length of time, and that the observed duration is not a physiological effect; he suggests winking the eyes and moving the head in order to notice the duration. He examined the files of a few journals for several years back, and gives a summary of some of the information found; he discusses the question of bands and successive discharges, showing some illustrations, but not direct reproductions, of some photographs; he suggests that the glowing streak may be an after effect of the electric discharge; Hoffert's photographs seem to show beyond question the complexity in lightning flashes, and that the duration is often as long as one-half or even one second. No general conclusions are drawn.

Annealing Harveyized Armor Plates. Dougherty. *Cassier's Mag.*, Mar.—An illustrated description of the apparatus and process devised by the Thomson Welding Co. and used on American battleships. The general principle is that a current like that from a welding machine is passed through the spot to be annealed, raising its temperature to about 1000°F., and very gradually and slowly reducing this current during a period of about 15 minutes so as to prevent chilling by conduction; the total weight of the annealer is about 1000 pounds, and the current generated by the transformer is about 10,000 amperes.

Electricity and Boiler Scale.—West. Elec., March 20.—An extract from the *National Engineer*, describing the case in which one of a number of boilers was found to be continually charged with electricity to such an extent that sparks could be drawn from it; this boiler never showed any sign of scale on the interior, while the others did; after another boiler was placed beside it these conditions were changed and it then acted like all the other boilers, it was no longer charged and scale formed.

Electric Germination of Plants. Kinney. *Elec. Eng.*, March 17.—A long abstract, accompanied by a number of illustrations, of the report which was noticed in the *Digest* last week.

Age of Electricity. Tesla. *Cassier's Mag.*, March.—Extracts from his recent address in Buffalo, an abstract of which was given in the *Digest*, Feb. 6; illustrations of portions of the Niagara Falls plant are included.

Biographical. Scholey. *Cassier's Mag.*, Feb.—An illustrated biographical sketch, with portrait, of Sebastian Ziani de Ferranti, together with illustrated descriptions of some of the electrical machinery which he has designed.

Magnetic Lock for Miners' Lamps.—Eng. & Min. Jour., Mar. 6.—A brief description of an English lock for a miner's safety-lamp, which can be opened only by means of a powerful magnet; the catch is held by a spring bolt no portion of which is accessible, but it can easily be withdrawn with the aid of a magnet.

Calculator. Low. *Jour. of El'ty*, October.—A continuation of the illustrated description of the Smith-Manifold Calculator for making the usual calculations of the electrical engineer.

New Books.

The Electrical Telephone. By Edwin J. Houston, Ph. D., and A. E. Kennelly, Sc. D. New York. The W. J. Johnston Company, 253 Broadway, 1896. 412 pages. Price, $1.00.

This book is the ninth of the Elementary Electro-Technical Series by the same authors, and is intended to present the field of telephony in the same manner that the preceding numbers of the series present their particular subjects. Like the other numbers of the series, this book is intended to be intelligible to the ordinary reader who has not read the others.

It therefore starts with the elementary principles of the instrument and passes on to the complete modern systems, including the line work, switchboards and other apparatus. There is a chapter on radiophony, or telephony with a beam of light as a carrier of wave impulses.

The vexed questions, when and by whom the original telephone and the more important improvements were invented, are wisely omitted, as they could add nothing to the value of an elementary work.

"A Treatise on Submarine Telegraph Cables; Their History, Construction and Working," is the title of a work that has been prepared by Mr. Charles Bright, C. E., F. R. S. E., and which will be published by Messrs. Crosby, Lockwood & Son, 7 Stationer's Hall Court, London, England, provided a sufficient measure of support can be obtained beforehand. The size of the proposed book is super royal 8vo., and it will contain about 600 pages, fully illustrated with drawings and diagrams specially prepared for it. The price to subscribers will be two guineas ($10.30, or, with American duties and exchange added, about $15), but after publication the price to non-subscribers will be three guineas.

Mr. Bright has been continuously occupied in submarine cable work for over fifteen years, so that he is amply qualified from extended experience to deal with the subject from the practical standpoint, while the papers of his father, the late Sir Charles Bright, have provided him with unequalled material for the historical section.

Mr. Bright's work contains a complete history of submarine telegraphy, treating the subject from the financial and political as well as from the technical side; it deals with the science and practice of cable laying and working in all their engineering and electrical details, including description of the latest improvements in high-speed machine transmission. The subject of insulation is dealt with exhaustively, and the methods of manufacture in producing gutta percha and india rubber-covered cores are completely described. A valuable feature of the book, too, is the section devoted to patents, in which all master patents are described fully and categorically. The book is one, in short, that an electrical library will scarcely be complete without, while it will particularly appeal to the specialist in telegraphy, telephony and insulated wires. Orders for copies may be sent to this office or directly to the publishers at the address given above.

A Novelty in Snap-Switches.

It was not very long ago when almost any kind of apparatus that would succeed in turning off and on incandescent lights was considered good enough for a switch. In modern installations, however, the switches for controlling groups of lights in electroliers or elsewhere are a very important part of the installation, and should receive most careful attention at the hands of engineers and contractors. In no other department of interior construction work has greater advance been made than in the direction of quick-acting switches for this class of work.

The chief requisites that should be possessed by a snap-switch are quick and positive action, and the impossibility of bringing the movable parts into such relation with the others that an arc may be formed in the switch. It is almost equally essential that when the switch is either in the "off" or "on" position, it should remain there, locked against accidental displacement.

The contacts, or that part of the switch to which the terminals of the circuit are attached, are naturally its most important portion. These contacts should have a large area, relatively, to the amount of current to be carried, and the contact made should be under considerable pressure. Without a large area the difficulties of heating and of cutting become prominent, and the necessity for the pressure is apparent when the permanency of the rated capacity of the switch is considered. If too light a pressure is used between the moving and stationary parts at the time of connection, there will be little cutting, and the switch will move freely, but it is obvious that it will not continue to carry its rated capacity of current without heating. It is also important to remember that, while the carrying capacity of a given area of contact is regulated by the pressure, this pressure also plays an important part in keeping

the contact surfaces in proper condition to carry the current safely. If a switch breaks contact by a movement the reverse of that by which it makes contact, it is liable to carry back on the moving parts the non-conducting metallic oxides formed by the repeated rupture of the circuit. The form of contact which most nearly fulfills the ideal conditions is the so-called "knife" switch. The points of such a switch should be thick enough to conduct away instantly the heat produced by the rupture of the current, and should be made of tough and elastic metal of high electrical conductivity. The difficulty with the ordinary knife switch is that, unless it is installed on a switchboard for large

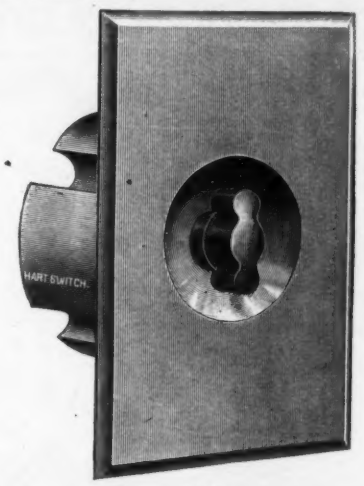


FIG. 1.—SNAP-SWITCH.

currents, where it is handled by persons of supposedly good judgment, it is apt to be slowly manipulated, with the result that the contacts are burned, losing both their shape and temper.

The manufacturers of the well-known Hart switch have taken into consideration these facts, and have placed upon the market a new line of switches, which seem to embody certain features free from these difficulties. It is evident that if thoroughly automatic action can be secured in a knife switch, and if there can be certainty that the contacts are at all times thoroughly made and instantly broken, by the simple turn of a handle, the conditions of ideal perfection will be very nearly reached.

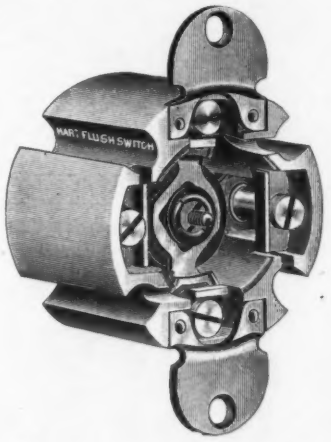


FIG. 2.—SWITCH MECHANISM.

FIG. 3.—TYPE OF CONTACT.

The flush switch which is illustrated herewith is a sample of their new line. This switch, while possessing heavy and durable mechanism and contacts, is also an indicating switch. The position of the handle at all times indicates the position of the switch. The handles of all the switches of the same capacity are interchangeable without affecting the indicating feature. The same rule applies to switches in gangs. The handles are of the self-adjusting type heretofore used on Hart switches.

Fig. 2 is an illustration of the ten-ampere, double-pole switch with finished face-plate removed, showing the mechanism and contacts inclosed by the base, which is one piece of porcelain. This base is provided with channels for the wire, the bared ends of which are clamped under binding screws accessible from the face of the switch after it is put in position in the wall. This feature greatly facilitates the installation of the switch, and especially of switches in gangs. Any member of a gang may be connected or disconnected and removed without disturbing the others.

Fig. 3 shows the type of contact used. Each binding post is provided with a pair of spring bronze clips, "c." Each end of the switch-plate, "B," is carried between a pair of these clips by the strong, instantaneous action of the switch mechanism. The connection thus made is practically perfect. The double-pole switches are "double-pole," "double-break" and "double-contact." Single switches and gangs of all sizes are carried in stock with face-plates of any of the standard finishes, and any special finish can be furnished promptly.

A line of iron wall frames and iron switch boxes for use with iron-armored conduit is also provided. No flush switch should be placed in a plastered wall without the use of such frame or box, or its equivalent, to provide a secure attachment for the switch and to prevent the plaster from crumbling around the edges of the opening.

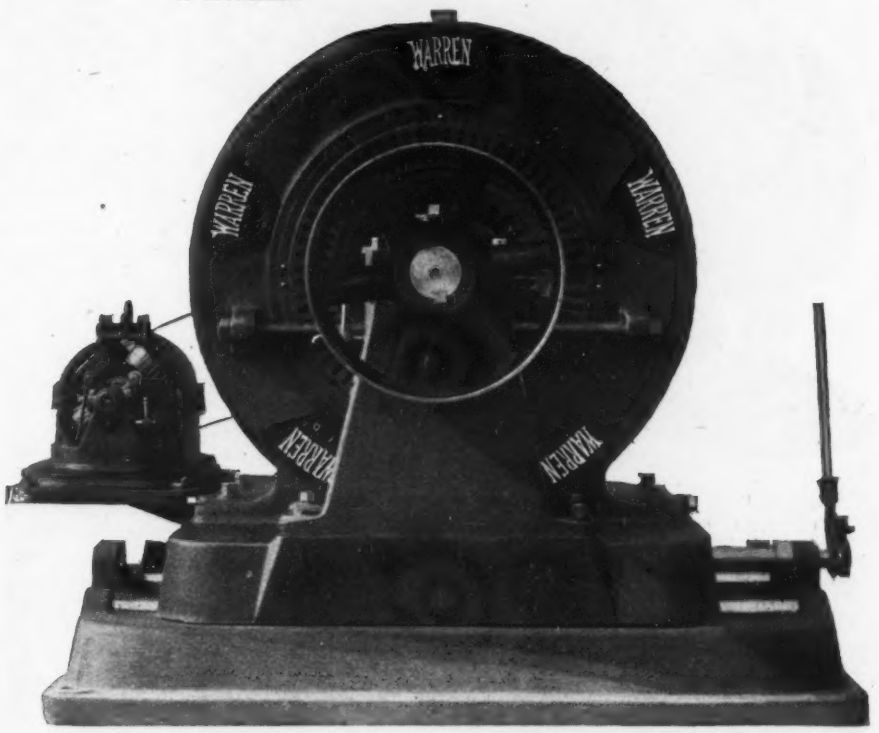
The Hart & Hegeman Manufacturing Company, Hartford, Conn., is confident that the wide use of its switches will be increased by the production of this new line, and that the excellent reputation which its goods have hitherto enjoyed will be extended by its introduction.

The Development of a New Industry.

Early in the present year the Warren Electric Manufacturing Company purchased the extensive manufacturing plant heretofore known as the Barney & Kilby Engine & Machine Works, in Sandusky, Ohio, and has refurnished the shops with machinery for the construction of the now well-known Warren alternator.

These machines differ from the ordinary type of revolving armature alternating generators in that they contain no moving wire. They are built upon the inductor principle, which is now regarded as the most modern, scientific and non-hazardous method for the construction of such machines. The present type of these dynamos is the result of over two years of arduous experimenting on the part of Mr. C. C. Warren, the president of the company, and his son, Mr. H. B. Warren.

Up to the time that the Sandusky factory was acquired by the Warren Company these machines had been built by contract, but, as might be reasonably expected, this plan was not entirely satisfactory. In the new factory, which is very substantially equipped, there is no doubt that the manufactures of the company can be produced more economically, successfully and satisfactorily than ever before, and that its well-known product will be improved beyond its present high standard of excellence.



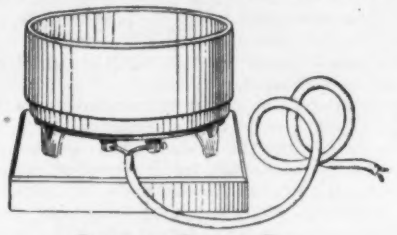
ALTERNATOR.

At the present time the Warren Company does not propose to build direct-current machinery of its own, but is prepared to contract for the construction of such machinery for other concerns. It is confining itself now to the manufacture and exploitation of its alternators only.

The situation of the factory at Sandusky is most desirable from many points of view. Five lines of railways and an excellent harbor on Lake Erie afford almost unsurpassed shipping facilities to every section of the country. The plant is a very extensive one, the fine stone buildings covering more than half of an entire city block. The officers of the company are as follows: C. C. Warren, president; Joseph F. Kilby, vice-president; H. B. Warren, secretary; Charles F. Mack, treasurer.

An Electric Solder Pot.

One of the most recent applications of electrical heating is the solder-pot illustrated herewith, which is designed for use in electrical repair shops and other places where it is necessary to keep on hand a small quantity of fluid solder. It is particularly useful for tinning wire, etc. It possesses great advantages of cleanliness, convenience, safety and close regulation over similar devices heated by either gas or gasoline.



Electric Solder Pot.

These pots are made in two sizes by the American Electric Heating Corporation, Boston, Mass. The smaller size holds four pounds of solder and requires 1.75 amperes at 110 volts, while the ten pound uses about twice the current.

Fan Motors.

The General Electric Company will this year, as last, place on the market fan motors for both alternating and direct currents, designating them as G. E. fan motors, '97 model. They retain the compactness and simplicity of the '96 models, with certain improvements.

The alternating-current fan motor is made for operation on currents of either 60 cycles or 125 cycles. The speed is regulated by an inductive resistance operated by a three-point switch, giving full speed and half-speed, and cutting off the current at the third point. The presence of this switch allows of direct connection of the motor to the circuit without the use of a socket and plug connection—an appreciable convenience.

The electrical design of this motor follows closely that of the '96 model. The field-core is a ring of iron punchings with inwardly projecting poles carrying the field-coils. The armature is a laminated core, through which, near the periphery, are run bare copper rods riveted to copper discs at each end of the core.

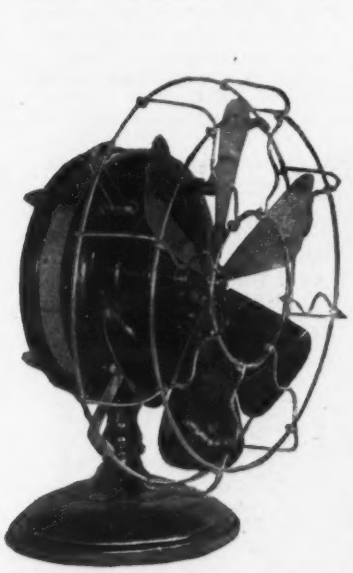


Fig. 1.—Alternating Current Fan Motor.

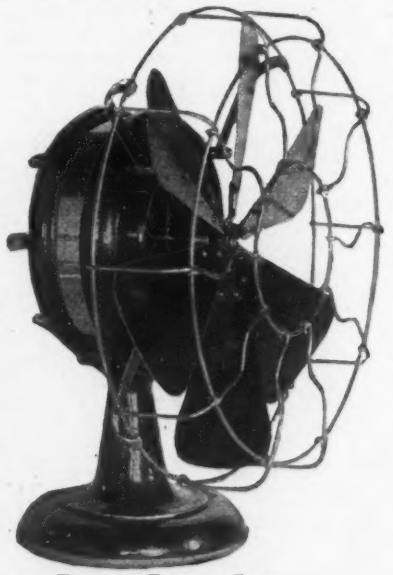


Fig 2.—Direct Current Fan Motor.

There are neither commutator nor brushes—rotation being produced by inductive action. This permits the core to overhang the bearing to such a degree that, together with the fan, a balance is effected, and the motor has but one bearing, long and provided with a self-oiling device, so that it does not heat. The fan is 10 inches in diameter.

The direct-current fan motor also has but one self-oiling bearing. The commutator is completely inclosed and the small carbon brushes are incased in tubes, which may be readily unscrewed for inspection. A regulating resistance and switch on the base allows of changes in the speed in the motor. The fan is 12 inches in diameter.

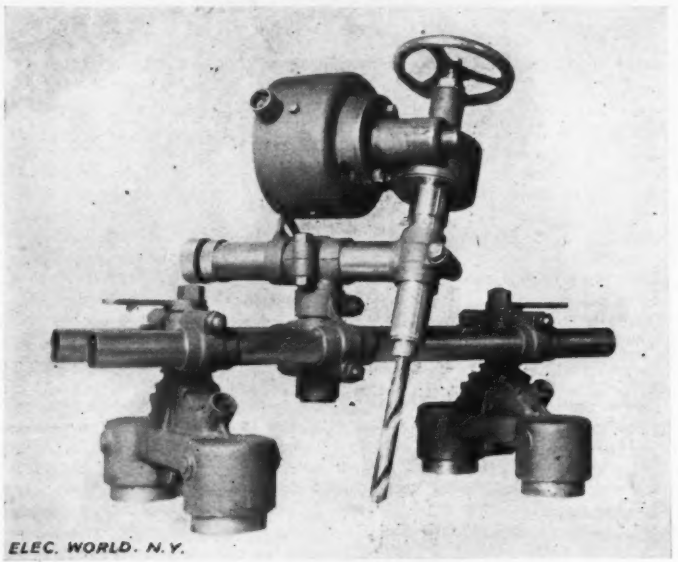
The finish of all '97 fan motors and fans is black japan, the guard-bindings, posts, nuts and screws being nickeled.

Portable Electric Drill.

The accompanying illustration shows a portable electric drill, the electric parts of which have been designed and built by the Lincoln Electric Company for the Portable Electric Drill Company, Cleveland, Ohio. The most interesting thing about this machine is the way in which it is clamped to its work. The drill is shown resting on four magnets. When these magnets are excited the machine may be used upside down or on a vertical surface. Each of the magnets has, it is stated, a pull of 1000 pounds on a flat surface.

The drill was designed for use on the sides of steel vessels, either for repairs or for new work, to take the place of the old-time hand-ratchet, and for general machine shop use. Complete, it weighs about 220 pounds and the pull of the magnets on an ordinary soft steel plate will, it is claimed, hold from ten to twenty times this weight, so that the drill has practically the same hold when working upside-down as when working right side up.

The motor is four-pole, has carbon brushes, is compound wound and is designed to take severe overloads without danger of sparking. In a recent test, it is stated, that the drill was several times fed so fast as to stop the motor, without any sparking or damage of any kind being done whatever. The full load may be thrown off or on without danger to the motor, which has ample power to drive a one-inch drill up to its full capacity, the speed of the motor remaining nearly constant whether the drill is cutting or not.



A Novel Electric Drill.

The machine is designed to use a voltage of 110, and a small corded flexible wire is used to connect it with the circuit. The wire is similar to that used for electric lighting, and is divided into three parts, each part being fitted with terminal plugs to be inserted in sockets, one at the motor and one at each set of magnets.

The machine is simple in construction and made as light as possible, consistent with good work. All of the castings are made of the best malleable iron, the tubes of cold rolled steel.

Some New Telephone Specialties.

There has been great difficulty experienced in putting tips on flexible telephone cords, since the tinsel, in order to be flexible, must necessarily be weak when strained.

Fig. 1. Fig. 2.

Mr. C. H. McEvoy, Lowell, Mass., has brought out a form of tip which is giving a great deal of satisfaction. Fig. 1 shows very clearly the "Duro" tip. The pin of No. 14 brass wire is passed through the covering and tinsel of the cord, and the tapered point is then bent over in the form of a hook. The conductor is bared for about a half-inch and a winding of small wire is put over both conductor and tip. The whole is securely soldered, and is then inclosed, either with another winding of heavy wire or a shell.

Another "Duro" specialty is the link shown in Fig. 2. No description of this efficient little article is necessary, as the cut tells the story perfectly.

Induction Desk and Ceiling Fans.

The practical application of the rotary current principle to desk and ceiling fans seems to have been well worked out by the Emerson Electric Manufacturing Company, St. Louis, Mo., in the apparatus described and illustrated herewith.

The induction desk fan (Fig. 1) resembles somewhat the "Meston" motors, which are manufactured by this company, and which have made an excellent reputation.

The armature, as is common with the armatures of all induction motors, has no insulation; therefore such a contingency as a burn-out is impossible.

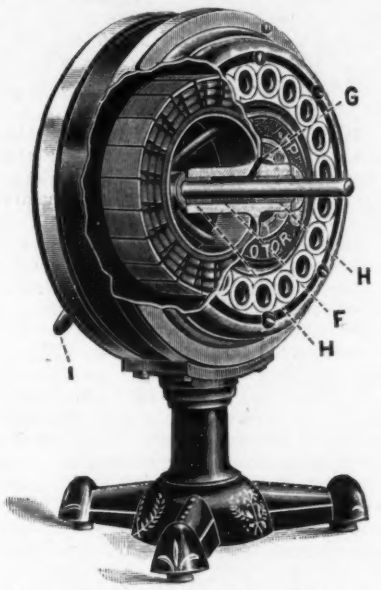


FIG. 1.—INDUCTION DESK FAN.

The operation of the motor is controlled by the regulating switch (Fig. 2), which is provided with six contact pins and a contact lever, with which the various connections are effected. The switch-handle may be placed in four positions, viz., "off," 1, 2 and 3. On the "off" point the motor receives no current, therefore that is the "stop" position; at 1 the motor starts and runs up to full speed, taking, approximately, 65 watts of energy; at 2 the motor will not start from a condition of rest, but if running at full speed when the handle is turned to the 2 position the machine will continue running at full speed, taking, approximately, 45 watts, and with the switch on the 3 position the motor runs at a slower speed, with greater economy of current, taking about 35 watts. The switch is at the back of the motor, and the handle is easily accessible, so that it can be readily changed.

These motors are provided with double bearings, which possess several advantages over the ordinary type of bearing. The bearings are bronze and the shaft of steel, which insures wearing surfaces of long life. Special oiling facilities are also provided.

The design of the fan itself has received careful attention, so as to obtain the best results in operation.

The efficiency of these motors is the strongest claim made for them by the company, the 12-inch motors consuming 45 to 50 watts.

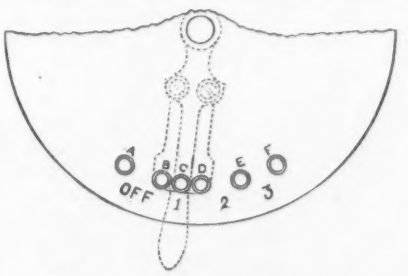


FIG. 2.—REGULATING SWITCH.

The induction ceiling fan (Fig. 3) in its general construction illustrates the "wheel within a wheel" principle—the outside wheel (the field) being stationary, while the inside wheel (the armature) revolves on a large solid shaft, resting on a ball bearing immersed in a cup of oil. It is unique in not having any moving wire, commutator, brushes, reduction gear of any kind or friction wheels. It runs at a speed of 150 to 210 revolutions per minute, and is claimed by the Emerson Company to surpass in simplicity of design and construction the best direct-current motors.

As shown in the illustration, the bearing is simply a long, upright shaft, provided with an oil cup at the lower end, the armature revolving on this shaft. This bearing requires but one oiling, and will run the entire season without further attention in this regard.

This motor runs at 210 revolutions at full speed, which can be regulated by turning the switch ("o" in the illustration) to a point midway between "off" and "on," which will reduce the revolutions to 150.

This ceiling fan is graceful and artistic in design; is noiseless in its operation, and consumes 125 watts of energy when running at a speed of 200 revolutions per minute. At 150 revolutions it takes 100 watts.

The Emerson Electric Manufacturing Company makes eight distinct types of fan motors, two each of 12-inch and 16-inch fans for 16,000

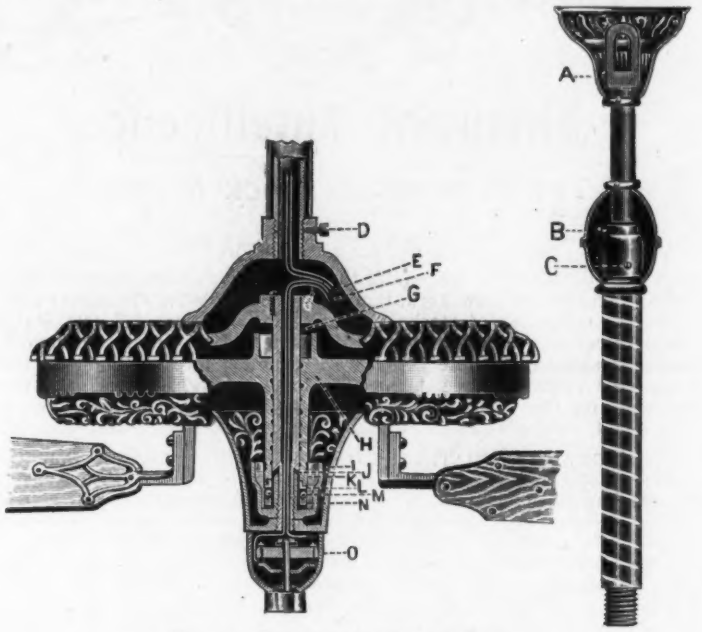


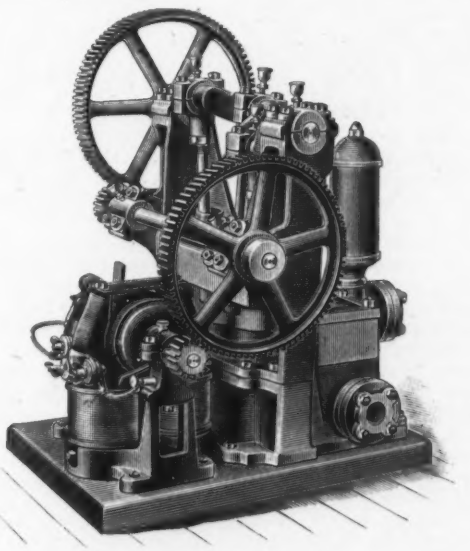
FIG. 3.—INDUCTION CEILING FAN.

alternations; one each of 12-inch and 16-inch fans for 7200 alternations, and one each of induction ceiling fans for 16,000 and 7200 alternations. The desk fans, it is stated, consume less than one-half the current required a year ago for this class of fans.

An Electric Boiler-Feed Pump.

We illustrate an electric boiler-feeding pump which has become popular in the designing of power plants in general, and which is specially adapted to electric lighting and railroad work. The economy of power boiler-feed pumps over direct-acting steam pumps is recognized by engineers having charge of construction and operation.

The pump shown is of the triplex, vertical, three-cylinder type. This arrangement of cranks produces a practically constant flow of water, as well as uniform strains in the gearing—features of advantage alike to boiler, pump and motor.



ELECTRIC BOILER-FEED PUMP.

The details of the pump are of standard design. It has outside packed plungers of bronze, steel shaft and connecting rods, cut gearing, heavy rigid frames, etc. The valves may be adapted either for hot or cold water, and have ample area. In places where the use of a motor for driving the pump is not convenient, tight and loose pulleys may be placed on the counter-shaft for belt power.

These pumps are built by Rumsey & Co., Limited, Seneca Falls, N. Y., for boilers ranging from thirty to three or four thousand horse-power, and will operate easily against a pressure up to 150 pounds per square inch.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, March 22, 1897.

ELECTRICAL STOCKS.—With the single exception of Edison Illuminating Company of New York, there has been a general retrograde movement in this class of stocks during the past week. Electric Storage Battery common lost 3 points and the preferred 4. General Electric declined fractionally, while no bids are recorded for Westinghouse common, the preferred stock being ½ point lower. The sales of General Electric for the week were 7202, the highest price being 35⅝, and the lowest 34, closing at 34⅝.

TELEGRAPH AND TELEPHONE.—Western Union Telegraph lost over 1 point compared with last week's quotation. The cause of the depression is supposed to be the action of the Governors of the Stock Exchange in refusing to renew the contract for continuing the ticker service. The total sales of shares of Western Union for the week were 23,850, the highest price being 86½, and the lowest 83¼, closing at 83¾. Bell Telephone dropped 1 point on the Boston Exchange, and Commercial Cable is 9 points lower. Other changes are fractional.

ELECTRIC TRACTIONS.—In this list Brooklyn Traction continues strong, while the general market remains quiet.

DIVIDENDS.—The Westinghouse Electric & Manufacturing Company has declared a quarterly dividend of 1¾ per cent. on its preferred stock, payable April 1.

The American Bell Telephone Company has declared a regular quarterly dividend of $3 per share, payable April 15.

REPORT OF OPERATIONS.—The New Orleans Traction Company reports gross earnings for February of $98,090, a decrease of $17,235 as compared with the same month last year; net earnings $33,870, a decrease of $22,200. The decrease in gross earnings for the two months ending February 28 was $22,461, and the decrease in net earnings compared with the same period last year was $40,919.

BELL TELEPHONE.—At the next annual meeting of the American Bell Telephone Company, which will be held on March 30, the matter of a stock issue will be presented to the stockholders for action. The amount of increase of stock to be asked will be fixed at a special meeting of the directors to be called before the annual meeting takes place. It is believed, however, that the stockholders will be asked to approve an increase of present capital of 10 per cent. This would increase the stock $2,360,000, making the total $26,015,000.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Chicago Edison Company	100	110	..
Edison Electric Ill., New York	100	106½	108
" " " Brooklyn	100	..	97
" " " Boston	100	..	..
" " " Philadelphia	100	..	..
Edison Ore Milling	100	7½	10
Electric Storage Co., Philadelphia	100	23	23½
Electric Storage, pref.	100	24	24½
General Electric	100	34¼	34½
General Electric, pref.	100	75	80
Westinghouse Consolidated, com.	50	..	25
Westinghouse Consolidated, pref.	50	50½	51½
BONDS.			
Edison Electric Ill., New York, con. 5s	105	108	..
Edison Electric Light of Europe	100	75	85
General Electric Co., deb. 5s	100	96	..
TELEGRAPH AND TELEPHONE.			
American Bell Telephone	100	221	223
American District Telegraph	100	29	39
American Telegraph & Cable	100	87	91
Central & South American Telegraph	100	124	127
Commercial Cables	100	156	175
Erie Telephone	100	..	66
New England Telephone	100	..	102½
Postal Telegraph-Cable	100	96	99
Western Union Telegraph	100	83½	83¾
ELECTRIC TRACTION STOCKS.			
Baltimore Traction	25	17⅞	18⅛
Brooklyn Rapid Transit	..	20¾	21½
Brooklyn Traction	100	..	14
Brooklyn Traction, pref.	100	46	48
Buffalo St. Ry.	100	73	75
Cleveland Electric Ry.	100	..	..
Columbus St. Ry.	100	41½	43½
Hestonville	100	50	51
Hestonville, pref.	..	..	62½
New Orleans Traction	100	..	10
New Orleans Traction, pref.	100	..	35
North Shore Traction	100	23	25
North Shore Traction, pref.	100	77	80
Rochester St. Ry.	..	18	22
Steinway Ry.	..	45	50
Union Railway (Huckleberry)	..	..	100
Union Traction, rcts $10 pd.	..	12¾	13
West End, Boston	100	70	71
West End, Boston, pref.	100	91	..
Worcester Traction	100	20	22
Worcester Traction, pref.	100	94	97
BONDS.			
Brooklyn Rapid Transit 5s, 1945	-00	79½	..
Buffalo St. Ry. 1st con. 5s	100	*106	108
Cleveland Electric Ry. 1st mtge. 5s	100	103	105
*Columbus St. Ry. 1st 5s	100	94	96
Rochester St. Ry. 1st 5s	100	..	100
Union Railway (Huckleberry) 1st mtge. 5s	..	*102	105
*Westchester Electric 1st mtge. 5s	100	100	103

*With accrued interest.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, March 23, 1897.

MR. S. P. SWIFT, the genial manager of W. R. Ostrander & Co., 22 Dey Street, seems to be fairly well satisfied with the concern's business for some time past and believes that times are improving.

THE HENRY ELECTRICAL SOCIETY.—The next meeting of this society will be held on Friday evening, April 2, when Mr. W. B. Potter will give a lecture on "Electric Railway Vagaries." On Friday, April 23, Mr. Alexander Stratton will deliver a lecture on "The Use of Different Kinds of Iron and Steel in Dynamo Electric Machines."

VISITORS TO NEW YORK.—Among the out-of-town visitors who registered at the office of the National Electric Light Association during the ten days ending Wednesday last were the following-named gentlemen: Mr. A. Anderson, Boston, Mass.; Dr. Louis Duncan, Baltimore, Md.; Mr. A. M. Young, Waterbury, Conn.; Mr. S. Whitaker, Newark, N. J.; Mr. A. J. Belden, Syracuse, N. Y.; Mr. H. Lewis, Philadelphia, Pa., and J. F. Mustard, Philadelphia.

"ARKOLIER" is a new name which Mr. G. R. MacIntire, of the International Arc Lamp Company, has recently coined for a particularly beautiful arc lamp fixture of his design. The lamp itself is exceedingly small and embodies a number of very novel features. Mr. MacIntire has recently built a lamp of this type measuring from tip to tip only 19½ inches with a capacity of 85 hours. Other novelties in the same line are also to be brought out shortly.

MR. E. B. GALLAHER, of the Gallaher-Bayliss Engineering Company, of this city, is the vice-president of the Manhattan Manufacturing Company, 120 Liberty Street. This company is exploiting a gas engine of Mr. Gallaher's design, which embodies a number of new and very novel features. The engine is to be specially applied to the propulsion of boats and vehicles and for operating dynamos. Mr. Gallaher is considering a direct-connected dynamo and gas engine combination.

ECONOMIC DYNAMOS AND MOTORS are being ably pushed in this vicinity by Messrs. Bidstrup & Graham, 35 Frankfort Street. These machines have many features of particular advantage. The motors and small-sized dynamos are of the bipolar, ironclad type, being very excellently designed, and built according to the most approved modern methods, the best material being used in all parts. The larger machines are of multipolar construction. Mr. Bidstrup reports quite a number of recent sales, and is wide-awake for business.

SMALL GAS ENGINE ELECTRIC LIGHT PLANTS seem to be absorbing the attention of Messrs. McLeod, Ward & Co., 27 Thames Street. They have recently made a specialty of this class of work, and have installed quite a number of small electric lighting plants, particularly in large stores using from 50 to 150 lights. They report that these plants are giving very great satisfaction, and effect great economy in each particular instance. They also express themselves as being

pleased with their other business. The specialties which they manufacture, especially the Kinsman desk lamp, are very much in demand.

MR. J. P. HALL, of the firm of J. P. Hall & Co., 143 Liberty Street, seems to have a peculiar knack of "getting there" on large wiring contracts. He has made a special feature lately of marine work. Amongst the boats recently equipped by his concern are the "City of Troy" and "Saratoga," of the Troy line, the "Albany" and "New York," of the Albany Day Line, four Brooklyn and New York ferryboats and several others. The electric plant including the wiring of the large office building of the Bank of Commerce at the corner of Cedar and Nassau streets, New York City, is also being installed by this enterprising concern.

THE SWAN LAMP PATENTS.—The Swan Incandescent Electric Light Company, 14 White Street, New York City, has applied to the Supreme Court for the voluntary dissolution of the company. The company was organized in 1882 with a capital stock of $800,000, to manufacture and sell electric lamps under the patents of Joseph W. Swan. From 1885 until two years ago the manufacture of lamps was carried on by a licensee—the Swan Lamp Manufacturing Company, Cleveland, Ohio—and the first-named company's only source of revenue was the royalty thus obtained. The licensee discontinued business two years ago, and since then the parent company has had no income.

SUCCESSFUL AGITATION.—The protest of the property owners and business men on Eighth Avenue, south of 59th Street, against the purpose of the Metropolitan Street Railway Company to introduce the underground trolley system down Sixth Avenue and not down Eighth Avenue, below 59th Street, has finally prevailed, and the Metropolitan Company has agreed to begin work on the installation of the system simultaneously on Eighth Avenue, south of 59th Street, and on Sixth Avenue, and push the work on both lines as rapidly as possible. This promise was made by President Vreeland on March 18 to a committee representing the West Side Improvement Association, which body conducted the agitation.

THE STANDARD ELECTRIC ELEVATOR & MANUFACTURING COMPANY, from its Eastern office, 156 Broadway, seems to be thoroughly up to the times in catching new business. It is pushing its electric elevator, which embodies a number of entirely new features and radical departures from ordinary elevator engineering. The machine is the invention of Mr. Frank B. Rae, the electrical engineer of the company. A number of these electrical elevators have recently been installed in this city. Among the more prominent installations may be mentioned those at the Trinity Court Building, Trinity Place; the De Courcey Building, 570-72 West Broadway; the Maggie Mitchell Apartment House, 102d Street and West End Avenue; the Ireland Building, West Broadway and Third Street, and the Hotel Cecil, 118th Street and St. Nicholas Avenue.

THE McLEAN ENGINEERING COMPANY, 136 Liberty Street, is doing quite a large business with its improved method of operating ordinary belted, drum-winding elevators. The company uses the Whittingham automatic motor starter and a specially designed switch, with any type of electric motor used for such purposes. The arrangement of this apparatus is such that the motor which drives the elevator mechanism is started and stopped in conjunction with the shifting of the belts by the ordinary shipper ropes, which are a part of the elevator mechanism. By this means a great point of economy is gained over other methods in which the motor is separately started, and runs either continuously or at intervals. The company makes a specialty of remodeling old installations, guaranteeing increased economy. The excellent results obtained in almost all of its installations appear to substantiate these claims.

PERMISSION GRANTED.—The New York State Railroad Commission has granted the application of the Metropolitan Street Railway Company, the Central Park, North & East River Railway Company, the Eighth Avenue Railway Company, the Ninth Avenue Railway Company, and the Sixth Avenue Railway Company to use the underground trolley system of propulsion on their roads. The four lines last named are operated by the Metropolitan Street Railway Company, and the proposed improvements cover the introduction of the underground trolley system along Fourth, Sixth, Eighth and Ninth Avenues and on the Belt Line on 59th Street, against which some opposition was brought to bear by the Third Avenue Railroad Company and others. Mr. William C. Whitney stated that it was the intention of the company to spend five or six million dollars in this work, and that the company would begin on the same very soon. It is stated that the consent of the Board of Electrical Control must be secured before the Metropolitan Street Railway Company will be allowed to lay underground electric conduits. The Metropolitan Company expects to have the Sixth and Eighth Avenue lines in operation by next Fall, six months being allowed for the construction of these lines.

STOCK TICKERS.—The governors of the New York Stock Exchange have, it is stated, determined not to renew the contract with the Gold & Stock Telegraph Company, which operates the ticker system. The present contract expires on June 30, and 90 days' notice of abrogation of the contract is required by the terms of the same. The Gold & Stock Telegraph Company is controlled by the Western Union Telegraph Company, and it is stated that the Stock Exchange governors were impelled to take this action because the ticker company has for five years violated its contract by placing tickers wherever it has seen fit, in New York City, without the required submission and approval of the Stock Exchange. It is also charged that the Western Union Telegraph Company contracted not to furnish to persons who may be directly or indirectly engaged in the promotion or maintenance of bucket shops, reports supplied by the Stock Exchange. This agreement, the governors of the Stock Exchange state, has been violated for five years and the telegraph company has been furnishing its reports, they state, to practically every bucket shop in the United States. The New York Stock Exchange Quotation Company, which is controlled by the governors of the Exchange, will continue to supply the quotations to the members of the Exchange.

NEW ENGLAND NOTES.

Branch Office of THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, MASS., March 23, 1897.

E. M. LANG & CO., Portland, Me., report a great demand for their wire drop and stick solder, both for electrical and industrial purposes. They have just put on the market a new electric fuse metal, which they manufacture in connection with their patent segment solder.

MR. C. H. McEVOY, Lowell, Mass., one of the pioneers in the manufacture of switchboard, medical battery and telephone cords, has recently brought out several "Duro" specialties. They have met with such universal favor that he has been obliged to extend his plant in order to keep pace with his orders.

THE NEW ENGLAND ELECTRICAL TRADES ASSOCIATION held its annual meeting and dinner at Young's Hotel last Friday afternoon, March 19. The following officers were elected for the ensuing year, most all of whom were re-elected to their several positions: President, Frank Ridlon; vice-president, Col. Elbert Wheeler; secretary, F. W. Brown; treasurer, A. T. Clark; Executive Committee, D. A. Andrews, P. M. Reynolds, W. S. Barker, Charles A. White and A. Drew.

THE PARAGON ARC LAMP COMPANY, Devonshire Building, Boston, has been appointed New England agent for the Shelby Electric Company, Shelby, Ohio, and its incandescent lamp manufactures. The company reports business as very good, particularly for its 100-hour lamp for series circuits. This lamp is designed to operate on either a 6.8 or 9.6 ampere current, and can be run on any of the standard arc machines. The Paragon Company claims that the lamp is absolutely steady in operation, and that it will give fully as much light, if not more, than the open series arc.

THE MAINE ELECTRIC COMPANY, Portland, Me., has recently installed an electric coal hoist on one of the Portland wharves, which is attracting a great deal of attention. Notwithstanding the fact that many people predicted a failure, Mr. James B. Phillips, the able manager of the company, has made the hoist a complete success. There are several very novel points in the construction of the machine which show a thorough understanding of the problem. It is in daily use unloading coal from the coal schooners, and proves conclusively the advantage of electricity over steam as a motive power. Mr. Phillips has installed on the lumber wharves several hoists of a slightly different design, which are constantly being used for the purpose of transferring lumber. The Maine Electric Company also manufactures dynamos and motors, which it is supplying to the trade in Maine and adjoining territory.

PITTSBURG NOTES.

PITTSBURG, PA., March 22, 1897.

LARGE INCREASE IN STOCK.—At a special meeting of the stockholders of the Central District & Printing Telegraph Company held on March 18, the capital stock of the company was increased from $2,500,000 to $4,000,000. This increase is for extensions and improvements, and has been made necessary by the large amount of underground work that is being done, and by the increase in the company's business. In view of the threatened competition by the Home Telephone Company the movements of the Central District & Printing Telegraph Company will be watched with interest. It has not yet shown any disposition to reduce its rates.

STREET RAILWAY CONSOLIDATION.—It is reported that the Northside Traction Company is making further overtures towards securing the Pittsburg, Allegheny & Manchester Company's property. A few months ago the Northside company offered to lease the Manchester road for 999 years, and to pay for the lease 4½ per cent. on the capital stock of the Manchester Company. This offer was not acceptable to some of the stockholders of the latter company, and was finally withdrawn. The Northside Company now offers, it is said, either to lease the property for 999 years on a five per cent. basis or to buy it outright at the rate of $47.50 per share for the entire 60,000 shares of its capital stock. It is believed that one of these propositions will be accepted by the stockholders of the Manchester Company.

THE HOME TELEPHONE COMPANY.—This company's Pittsburg ordinance, previously referred to in THE ELECTRICAL WORLD, came before the Common Council on March 15, and was passed in its original form by a practically unanimous vote. It will now become a law as soon as it is signed by the Mayor. The Home Company's Allegheny ordinance was referred to a sub-committee which met on March 20, and tacked a number of restrictions to the original ordinance. The city is to receive an annual tax of two per cent. on the gross receipts of the company, and is to get free telephones in all the city offices, engine houses, school houses, and residences of officials who may require telephone service. The company must begin work by June 1, and 300 telephones must be in operation inside of a year, or the franchise will be revoked. The company cannot sell its franchise, and if it should at any time merge with another company the latter will be subject to the Home Telephone Company ordinance.

Cleveland Notes.

Cleveland, O., March 20, 1897.

TELEPHONE COMPETITION.—Free telephone service to all points in Trumbull County is assured the Warren people, after the Jefferson-Warren Company gets an exchange in that town. At present it costs twenty cents to talk to the northern part of the county. Only subscribers will have the benefit of the free communication with outside villages.

ANOTHER MICHIGAN CONTRACT.—Mr. C. H. Lawrence of the United States Railway Equipment & Construction Company was in Cleveland last Monday on his way to Indianapolis. His company has just closed a contract with James G. Tucker, receiver of the Detroit & River St. Clair Railway, for the construction and equipment of a road from Mount Clemens to Marine City. Work will be commenced early next month, and the contract calls for the completion of the road by July 15. The road opens up a territory hitherto without transportation facilities, except by boat. In addition to a large transfer business with the Rapid Railway Company at Mount Clemens, the company estimates an annual freight business of about 15,000 cars at the junction of the Grand Trunk Railroad Company's tracks at Chesterfield. The road will be 33 miles long, and the schedule running time will be 45 miles per hour. The Walker Manufacturing Company, Cleveland, Ohio, will furnish the electrical equipment.

A BIG CONTRACT IN RAILROADING.—The Century Engineering Company, Cleveland, Ohio, has contracted for 100 miles of electric railroad, which, according to stipulations, is to be completed by September next. The road will commence at Benton Harbor, Mich., and, running by a private right-of-way, through the finest fruit country in the United States, will extend to Sister Lakes, branching north to Allegan and south to Casapolis, affording transportation to neighboring small towns along the route, which have hitherto been at a disadvantage as regards passenger and freight traffic. The first 15 miles of road will be built of 80-pound T rail, and the balance of 70-pound T rail, over a track of cedar ties 6x8x8. The cars will consist of passenger, freight and standard fruit cars. The company, through its consulting engineer, has decided to use the marine type of engine and Scotch boilers. The engines are of the inverted, direct-connected type, cylinder 20 and 40 inch in diameter, by 30-inch stroke, direct connected to the generators. They are to generate 700 indicated horse-power, at ¼ cut-off. The boilers are the Scotch, single-ended type, about 12 feet by 12 feet, to carry 125 pounds pressure of steam. There are to be four power houses on the line, each station to feed 15 miles each way, and to be equipped with two direct-connected 400-kw generators, except at Benton Harbor, that station having three direct-connected 450-kw generators. Contracts for equipments have not yet been let. The Benton Harbor Electric Railway & Transit Company, by whom the contract is let, proposes to run a boat line from Benton Harbor to Chicago and Milwaukee, the direct connection thus afforded between this section and many of the large cities of the lakes will be of inestimable benefit to the fruit-growers, as well as a source of revenue to the Company.

Chicago Notes.

Branch Office of The Electrical World,
936 Monadnock Building,
Chicago, Ill., March 22, 1897.

MR. F. A. ROSS, mining and electrical engineer, late of Montana, has accepted the position of general manager of the Stromberg-Carlson Telephone Manufacturing Company, Chicago. Mr. Ross is a hard-working-up-to-date business man, and it is expected that he will revolutionize the telephone business in this section of the country.

TO ENLARGE ITS REPAIR DEPARTMENT.—The Charles E. Gregory Company, 47-53 So. Jefferson Street, Chicago, has secured more commodious quarters at 51-53 So. Jefferson Street, for its repair department. The enlargement of this department was rendered necessary on account of the rapid and steady increase in the repair work, and the new quarters have been equipped with superior facilities for turning out the best of work in the shortest possible space of time. The new quarters adjoin the company's warehouse, and the extended facilities will enable the company to better display and handle its large stock of machinery, apparatus, supplies, etc.

FIRE AT THE CHICAGO EDISON STATION.—A fire, which for a time assumed a threatening aspect, broke out in a pile of waste in No. 2 station of the Chicago Edison Company, at 2640 Wabash Avenue, on the morning of March 20. Quick work, however, saved the plant, and the damage will not exceed $3000. A fireman ruined a dynamo by chopping into it with an axe. With this exception, the damage was almost entirely caused by water. The plant carries 56,000 incandescent lights between Sixteenth and Thirty-ninth Streets.

St. Louis Notes.

St. Louis, Mo., March 20, 1897.

OPPOSED TO REORGANIZATION.—There is some opposition to the reorganization of the Peoples' & Fourth Street and Arsenal Street Railways, which recently went into the hands of a receiver. To reorganize the roads it would be necessary for the bondholders to pay off the floating indebtedness, which amounts to $240,000. Some of the bondholders think it would be best to sell the roads and divide the proceeds. These, however, are very few in number. Even if the local bondholders agree, nothing can be done until all of the bondholders have been consulted. This will take about two months.

LOW TELEPHONE RATES.—The Kinloch Telephone Company has inserted an advertisement in the daily papers, in which it gives the telephone rates it proposes to give subscribers. The company commenced a week ago to lay conduits, and is already building its exchanges. It proposes to the people of St. Louis to give first-class service at reasonable rates. Another feature it promises is that every telephone will be a long-distance instrument on a metallic circuit. There will be no "limited service," and all subscribers will be permitted to talk as long and as often as they please.

Pacific Coast Notes.

San Francisco, Cal., March 13, 1897.

THE POWER DEVELOPMENT COMPANY has completed its initial installation at its water-power station in the Kern River canyon, 16 miles east of Bakersfield, Cal. The pipe line caused a slight delay, but the machinery will soon be in operation.

THE SAN FRANCISCO ELECTRICAL COMPANY, 415 Market Street, San Francisco, which holds the agency for the Standard and National telephones, recently took the agency for the Eddy generators and motors. H. P. Thayer is the manager of the company.

THE HOME TELEPHONE COMPANY, Los Angeles, Cal., expects to construct this year a system to connect the principal towns in Southern California, and which will in time, connect with the exchange at San Jose. F. W. Braun is the president of the company.

ELECTRIC TRACK WELDS.—The Piedmont & Mountain View Railway Company, Oakland, Cal., will soon have its electric tracks welded by the Falk Manufacturing Company, Milwaukee, Wis. The latter Company has also taken the contract to weld 1000 joints in Los Angeles, Cal. This will be the first work of its kind to be done on the Coast.

THE SIEMENS & HALSKE ELECTRIC COMPANY supplied the four 4-kilowatt dynamos for the two United States gunboats just completed at the yards of the Union Iron Works. This is claimed to be the first order for generators on naval work, given to any company, except the General Electric Company, in the past eight years. The Union Company has taken the Pacific Coast agency for the Morton-Wimshurst-Holtz static machine.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, through its San Francisco agency, recently made the following sales: To Francis Smith, Redding, Cal., a 2-phase generator of 45-kw capacity, to be used to operate motors, etc., for mining purposes; to the Alaska Packers' Association 14 small generating and motor installations (direct-current generators from 10-hp down) for use in the canneries controlled by the combination; to Geo. B. Dow a 100-hp 2-phase alternating current mining hoist; also, a number of motors to be used for a variety of purposes in connection with his extensive mining and milling operations in Tuolumne county, Cal.

THE SOUTHERN CALIFORNIA POWER COMPANY.—The early reports concerning the recently-incorporated Southern California Power Company have proved to be well founded. The capitalization is $1,000,000 and the principal place of business is Redlands, Cal. The principal stockholders are Henry Fisher, Pittsburg, Pa., and H. H. Sinclair, president and manager of the Redlands Electric Light & Power Company. The new company proposes to develop the power of the Santa Ana River by taking the water out at the junction of that river and Bear Creek, carrying it in a cement ditch and tunnels four miles, thus obtaining a fall of 1100 feet, and then returning the water to the stream. The estimated capacity is 10,000 horse-power. The power station will be located at the head of the present Bear Valley canal. Power will be transmitted over a pole line, seventy-five miles in length, to Los Angeles, where it will be used for street railway and lighting purposes. It is expected to be the longest line of its kind, and to have the highest voltage in the world. The current will be transmitted at 30,000 volts. Work is expected to begin in April. Power is to be delivered in Los Angeles by 1898. The towns of San Bernardino, Pomona, Ontario and Pasadena will be touched by the line, and power will be supplied where desired. The famous "loop line," or "kite-shaped track," of the Southern California Railway Company may be operated from the new source of power.

Canadian Notes.

Niagara Falls, Ont., March 15, 1897.

TO PROMOTE HOME INDUSTRY.—It is probable that there will be several amendments to the Assessments and Municipal Acts of the Province of Ontario affecting street railway property. The government has been asked to enact that it be a condition in granting subsidies to railway companies that all rolling stock be manufactured in Canada.

WANTS A FRANCHISE.—A petition has been presented to the Ontario Provincial Government for an act to incorporate the Toronto Railway Company. The Company desires to secure all the personal prop-

erty, franchises and privileges owned by the Toronto Belt Line Company and convert the same or any portion thereof into an electric railway system.

MINERAL AND TIMBER ELECTRIC RAILWAY.—The Ontario Provincial Government has been petitioned to incorporate the Mineral & Timber Electric Railway Company, giving it power to construct, lay out, and build a railway from a point between the village of Chelmsford, Algoma and the town of Sturgeon Falls, Nipissing, and with power to extend said railway.

THE HAMILTON, GRIMSBY & BEAMSVILLE ELECTRIC ROAD has decided not to build the proposed extension from Beamsville to St. Catharines. It is announced, however, that ten Hamilton capitalists have decided to go ahead with the line provided they can get power cheap enough from the Cataract Power Company and a reasonable bonus is granted by the City of St. Catharines.

RUNNING ELECTRIC CARS ON SUNDAY.—The greatest astonishment is expressed in the decision of the High Court of the Province in the construction placed upon the "Lord's Day Act," which it was supposed prohibited the running of electric cars on Sunday. The Hamilton Street Railway Company resolved to test the law and so operated its electric trolley lines on Sunday. One John Henderson made the complaint through the Attorney-General of the Province. The Courts have held that an incorporated company or person operating street cars on Sunday was not within the prohibition of the enactment. This will be good news to all electric lines in Canadian cities, and has been a big bone of contention in Toronto, where the matter has been submitted to popular vote and narrowly defeated twice.

General News.

NEW INCORPORATIONS.

THE FALL RIVER ELECTRIC POWER COMPANY, Denver, Colo., has been incorporated with a capital stock of $250,000. The incorporators are W. R. Rundle, N. A. Chamberlain and B. F. James.

THE McHENRY COUNTY TELEPHONE COMPANY, Marengo, Ill., has been formed with a capital stock of $2500. Those interested are A. B. Coon, J. Q. Adams, F. L. Nutt, F. W. Patrick and N. V. Woleben.

THE ASHTABULA TELEPHONE COMPANY has been incorporated at Ashtabula, Ohio, by S. W. Crosby, B. M. Barber, James A. Paisley, W. H. Morrison and J. B. McKay. The capital stock of the new company is $15,000.

THE COOPER GENERAL MACHINE & ELECTRIC COMPANY, New York City, N. Y., has been incorporated with a capital stock of $10,000. The incorporators are Robert Cooper of Jersey City, Charles W. Congdon and James H. Williams of Brooklyn.

THE BUFFALO, HAMBURG & AURORA RAILWAY COMPANY, Buffalo, N. Y., has been incorporated with a capital stock of $200,000, by William H. Wheatley of Brooklyn. The company will construct a road eighteen miles in length from the Buffalo city line to East Aurora.

TELEGRAPH AND TELEPHONE.

BUSHNELL, ILL.—The Central Union Telephone Company is seeking a franchise to establish an exchange in this place, and an ordinance has been presented with this end in view.

DOWAGIAC, MICH.—Local capitalists are seeking a franchise for a telephone exchange which is calculated to furnish telephone service at one-half the rates charged by the Bell Company.

BOSTON, MASS.—It is stated that a large number of telephone subscribers in various cities of Massachusetts have signed protests against the creation of a telephone commission for the regulation of telephone rates.

BLOOMDALE, OHIO.—The business men of this place and Bairdstown have united in a proposition to the Bell Telephone Company which will insure the location of telephone connection at both places. This service has long been desired.

MONROEVILLE, OHIO.—The Monroeville Telephone Company, which is operating a local exchange in this place, has entered into a contract with the Harrison Telephone Company, of Norwalk, to build a communicating line between Norwalk and Monroeville, and establish a toll rate of ten cents for service between the two places.

NYACK, N. Y.—The Rockland Telephone & Telegraph Company has sold its property and business to the New York Telephone Company, of New York City. It is stated that the efforts of the Rockland Company to conduct a telephone business at rates ranging from $2 to $3 per month have been unsuccessful. These rates, it is stated, were too low. The company's plant was an isolated one, having no connections with outside lines, and it could not, for this reason, get the subscribers that it expected.

GRAND RAPIDS, MICH.—Negotiations are now in progress for the connection of all the independent telephone systems in the State with the ultimate object of establishing a system in opposition to the Bell Telephone Company. It is proposed to give the most complete service possible, and the lines will include all portions of the State under the metallic circuit system. The Citizens' Telephone Company and the new State Telephone Company are deeply interested in the plan, and the Citizens' Company will enter into a contract with the new State Telephone Company, and thereby secure connection with the different cities and towns throughout the State.

ELECTRIC LIGHT AND POWER.

BEAVER DAM, WIS.—The city is negotiating for an electric light plant of its own to compete with the local company that has been furnishing light for the past ten years.

EDINBURG, IND.—The citizens of this place are agitating the question of electric light, and have signified their intention of putting in a plant, to be owned and operated by the town.

ELROY, WIS.—The Elroy Electric Light Company proposes to locate at Union Centre and furnish electric light to Wonowoc. A franchise will probably be granted to the company.

RICHMOND, IND.—The ordinance providing for an issue of bonds to provide money for the purchase by the city of the electric light plant of the Richmond Light, Heat & Power Company was voted down.

MEMPHIS, TENN.—The committee appointed to consider the subject of a municipal electric plant has reported favorably upon the plan, and a bill authorizing the city to issue bonds has been recommended for passage.

COLUMBIA, S. C.—It is stated that the Columbia Water Power Company has decided to apply for a charter to enable it to carry on an electric light business. The plant of the new company will utilize water power, of which it has an almost limitless store.

NORWICH CITY, CONN.—The statement is made that the Norwich City Gas Company and the Norwich Electric Light Company are to be consolidated and their joint affairs administered by a new corporation to be known as the Norwich Gas & Electric Company. Among those interested in trying to bring about the consolidation are William C. Mowry, Morris F. Tyler, E. N. Gibbs, Garret A. Hobart, A. M. Young and George E. Terry.

THE ELECTRIC RAILWAY.

ALTOONA, PA.—A number of local capitalists have projected a new trolley line to run from the centre of the city five miles to Elmwood.

ASHLAND, PA.—The electric railway is to be extended from Centralia to Ashland.

COXSACKIE, N. Y.—This town is to have an electric railroad, with a capital of $50,000. The line will be five miles in length.

CUMBERLAND VALLEY, PA.—It has been practically decided to run the new trolley extension from Boiling Springs to Mt. Holly via Island Grove, a once celebrated Summer resort.

ENFIELD, CONN.—The Legislature has passed a bill granting a charter to the Enfield & Longmeadow Electric Railway Company to lay tracks and operate cars over the middle roads to Hazardville and Somers.

MEREDITH, N. H.—An effort is being made to secure a charter from the New Hampshire Legislature to build an electric railroad from Meredith, via Sandwich, to Conway.

GLENWOOD, N. Y.—The Lock City Electric Railroad Company is contemplating extending its lines this season so as to reach Cold Springs and Glenwood cemeteries.

HARRISBURG, PA.—A charter was issued to the Monongahela Valley Traction Company to build an electrical road in Washington County eighteen miles long.

OTTAWA, ONT.—The contract for additional motors for the St. John Railway Company has been placed with Ahearn & Soper, Ottawa, Canadian agents of the Westinghouse Company. The equipments will be of the Westinghouse 12-A type.

TONAWANDA, N. Y.—The Tonawanda Electric Railroad Company, of this place, and the Tonawanda Street Railroad Company, of North Tonawanda, have been granted the privilege of crossing the bridge across Tonawanda Creek. This connection will give through service from Gratwick and North Tonawanda to the Buffalo City line. It is contemplated to consolidate these two roads and extend the line to Niagara Falls, thus forming a through line from Buffalo to Niagara Falls. The road will be operated under the name of the Buffalo, Tonawanda & Niagara Falls Electric Railroad Company. Work will be pushed forward as rapidly as possible.

PERSONAL NOTES.

MR. HERBERT C. GUNTON and Mr. Harold Lomas, two English electrical engineers, are now in this country, visiting various central station plants and writing descriptions of the same for publication in the London "Electrical Review." They will also describe important American power transmission and railway installations.

PROF. LOUIS B. MARKS, well known as the inventor of the "Pioneer" inclosed arc lamp of the Electric Arc Light Company, New York, has been the recipient of marked honors abroad. He was invited by the Societe Internationale des Electriciens in Paris to address it on the subject of inclosed arcs. So much interest was shown in Prof. Marks' lecture that steps were immediately taken to introduce the "Pioneer" on a large scale throughout France. Prof. Marks next went to London, and created a very strong sentiment in favor of the inclosed arc system by his talk before the Royal Institution. While in Europe Mr. Marks has done much to add to the reputation abroad of American inventors.

MR. H. T. BARNETT, of the Electric Power Storage Company, London, who has been in this country for some months on behalf of the

Faure-King storage battery patents, has returned to England. He was highly pleased and gratified with America and with the success which attended his enterprises here. Mr. Barnett expects to return to New York some time during the coming summer.

MR. GEORGE C. BAILLARD, an active salesman, with the General Electric Company, has decided to sever his connection with that company. He has succeeded in building up a large lamp trade in the region of Greater New York, and as he is a man who carries his customers with him it is not likely he will remain long unemployed. He has a large business acquaintance and possesses great tact and ability.

MR. HERMAN A. STRAUSS, electrical engineer, has recently opened an office at 54 Maiden Lane, New York, where he proposes to conduct a business as a consulting and contracting engineer. Mr. Strauss bears an excellent reputation, both as to ability and character. He spent five years abroad, during which time he was graduated from the Royal Polytechnic, Berlin, Germany. He has been on the engineering staff of the Westinghouse Electrical & Manufacturing Company for the past five years, during which time he was actively engaged on the design on the electric plant of the Cataract Construction Company at Niagara Falls. Mr. Strauss is a member of the A. I. E. E. He is the author of treatises written for the International Correspondence School, Scranton, Pa., on electric lighting and dynamo electric machine designs. Mr. Strauss will make a specialty of single and polyphase alternating-current work, particularly for power transmission.

Trade and Industrial Notes.

"FACTS WORTH CONSIDERING."—The Royal Electric Company, Peoria, Ill., has just issued another edition of its pamphlet entitled, "Facts Worth Considering." This pamphlet contains useful information for central station owners, and will be mailed to all who desire a copy.

THE J. M. CARPENTER TAP & DIE COMPANY, Pawtucket, R. I., has just issued a new catalogue of screw cutting tools for bicycle repair work, containing price lists of its goods of the kinds and sizes used in the make-up of bicycles. This catalogue (No. 11 B), will be sent free to every one asking for it.

THE DAVIS & EGAN MACHINE TOOL COMPANY, Cincinnati, Ohio, has just secured the services of M. P. Sparks, previously identified with the tin plate business at Crawfordsville, Ind. Mr. Sparks is a thorough mechanic, and will represent the Davis & Egan Machine Tool Company, in Ohio, Indiana and Kentucky.

THE QUAKER CITY ELECTRIC COMPANY, Philadelphia, Pa., will in a few days issue a new, illustrated, descriptive catalogue of its new machines for various classes of service. This catalogue will consist of twenty pages and contain eight or ten nice illustrations, and it will be mailed free upon application to interested parties.

MR. R. S. HALE, Boston, Mass., agent of the Wright Demand Meter, has opened an office at 31 Milk Street, in that city, and will there conduct an engineering business in steam, mechanics and other branches of the engineering profession. Mr. Hale will furnish plans, estimates, specifications, reports, designs, etc., and will make inspections.

THE PARTRIDGE CARBON COMPANY, Sandusky, Ohio, manufacturer of self-lubricating motor and generator brushes, reports running full time and to the utmost capacity of its works. The orders so far received this month run from 500 to 20,000 carbon brushes, and, judging from the mail orders daily arriving, it bids fair to continue at this ratio throughout the Spring and Summer.

THE BALL & WOOD COMPANY, engine builders, 120 Liberty Street, New York, reports that business in the West and South continues to show some improvement, although the bulk of its orders still come from the East. In New York and Brooklyn alone this company is preparing to put under steam some thirteen of its standard direct-connected engines, all of them installed in the last few weeks in prominent office and other buildings.

THE ELECTRIC RAILWAY EQUIPMENT COMPANY, Cincinnati, O., has met with unexpected success in the sale of its mast arm. This arm is said to have advantages and none of the disadvantages of some of the arms that are on the market. These arms are used exclusively in the streets of Cincinnati and are highly recommended as to their efficiency and operation by those acquainted with their workings. With its increased facilities this firm can fill all orders promptly.

THE ELECTRIC APPLIANCE COMPANY, Chicago, advises its customers, and the electric railway trade generally, that it has made arrangements with the Ohio Brass Company to carry a complete line of the latter's railway specialties in Chicago stock. The electric railway trade will undoubtedly appreciate the advantage of being able to send large or small orders for the Ohio Brass Company's specialties, and have the goods shipped from Chicago on the day the order is received.

THE WALDRAN BRAKE HANDLE.—On March 20 the St. Louis & Kirkwood Railroad Company, St. Louis, gave a trolley car ride to the Meramec Highlands, to a party of invited guests, in order to afford those interested an opportunity to inspect and test under actual working conditions the alleged merits of the Waldran automatic brake handle. The party made the ride on the buffet car "Rambler," and refreshments were served en route and at the Highlands pagoda at Meramec Highlands.

BELTS FOR THE TENNESSEE CENTENNIAL.—Messrs. Charles A. Schieren & Co., 45-51 Ferry Street, New York, the well-known manufacturers of leather belting and laced leather belt, have secured the contract for furnishing the 36-inch leather belt for the Tennessee Centennial to be held at Nashville. This is the main belt and is said to be the only large one that will be used in the exposition. Messrs. Charles A. Schieren & Co., are to be congratulated on their success in obtaining this desirable contract.

WILLIAMS' ENGINES.—Messrs. William Tod & Co., Youngstown, Ohio, have just issued a pamphlet describing the Williams' improved vertical engines of which this Company is the builder. It is claimed that these engines possess several advantages, among which may be mentioned minimum frictional resistance and consequent minimum wear, especially on the pistons. These vertical engines possess all of the refinements requisite for direct-connection to electric generators and are extensively used in this work. The catalogue gives some excellent illustrations of practical applications of the Williams engine as well as detail diagrams of the parts.

THE "ALL RIGHT FAMILY" OF TORCHES.—This is the title given to four torches manufactured by the Clayton & Lambert Manufacturing Company, Ypsilanti, Mich., which torches are meeting with much favor among electric wiremen. The demand is constantly increasing in the electrical trade. These linemen's torches possess a good many features of merit and are highly recommended for the use of electric wiremen. They give perfect satisfaction in practical operation and they are very durable. These torches produce a large pure blue flame with very intense heat, and it is claimed that they consume less gasoline than any other torch, at the same time giving a stronger fire.

MR. E. B. LATHAM, New York manager of the Lakon Company, Elkhart, Ind., has recently returned from a trip through New England and Northern New York, which resulted in the capture of several very satisfactory orders for transformers. Mr. Latham states that the business outlook for the coming season is very satisfactory. The company has received through the New York office orders from Egypt, Guatemala and other South American countries during the past week, which go to show that the Lakon transformer is receiving well-merited consideration abroad as well as at home. The company's factory is kept very busy with its Spring business, and the future is very promising.

MESSRS. THOMAS & HUNTER, Richmond, Va., are now engaged upon the construction of a number of telephone exchanges and other plants in the South. At Augusta, Ga., they have nearly completed a large telephone exchange, while they have exchanges under construction at Savannah, to be completed by Aug. 1, and at Charleston, S. C., to be in operation by June 1. The same firm is also installing the lighting plant in the new buildings of the University of Virginia, and is building a plant, using Warren alternators, at Wilson, N. C. They report a very favorable outlook for business in the Southern States this Summer, and are to be congratulated upon their good fortune in securing so much of it.

THE WARREN ELECTRIC MANUFACTURING COMPANY, Sandusky, Ohio, who recently purchased the large machine works formerly occupied by Barney & Kilby, and who during the past six weeks have been renovating the entire plant, preparing for the building of the Warren alternator, has during the time specified built and shipped five alternators, ranging in capacity from 45 to 75 kw. Not one of these orders was solicited, owing to the chaos existing at the works. Within a few weeks everything will be ship-shape, when the orders now on the books will be filled, and Mr. Warren will be seen scurrying from East to West, securing, here, there and everywhere, orders, orders, orders, for the Warren alternator.

A LARGE NUGGET OF PLATINUM.—At the New York office of Messrs. Baker & Co., Newark, N. J., the well-known platinum refiners, which is located at 121 Liberty Street, is on exhibition a large nugget of crude platinum, that is attracting considerable attention. The nugget, which is believed to be the largest ever exhibited in this country, was contained in a recent shipment of crude platinum to the above named firm. It is, as usual, of irregular form, and measures approximately three by two by three-quarters inches. Its weight is nearly two pounds. This large nugget is attracting the special attention of metallurgists who rarely have the opportunity of seeing so fine a specimen of this precious metal. It is the admiration of all who see it. At the present market price for platinum the value of this nugget is about $336.

THE WILLIAMS & ABBOTT ELECTRIC COMPANY, Cleveland, Ohio, manufacturers of magneto bells, which in January last consolidated with the Kirk-Latty Manufacturing Company, as already reported in THE ELECTRICAL WORLD, was incorporated March 13, under the laws of the State of Ohio, and will hereafter be legally known as the Williams-Abbott Electric Company. The officers are: S. D. Latty, president; H. T. Latty, vice-president; F. M. Kirk, treasurer; C. B. Abbott, secretary; Samuel Abbott, Jr., superintendent and J. A. Williams, electrical engineer. The Kirk-Latty Manufacturing Company, manufacturers of hardware, has moved its entire works from Hamilton Street, Cleveland, to its new and commodious building situated at the junction of the Nickel Plate R. R. and Johnson Street, West Cleveland, and here has been reserved ample space for the Williams-Abbott Electric Company, where with the latest improved machinery, and an increased number of skilled workmen, its well-known magneto bells can be promptly delivered in orders of any magnitude.

Business Notices.

THE ILLUSTRATIONS in this issue were made by the Photo-Engraving Company, 67-71 Park Place, New York City.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, 105 South Warren Street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED MARCH 16, 1897.
(In charge of Wm. A. Rosenbaum, 177 Times Building, New York.)

578,707. CONTROLLING MECHANISM FOR ELECTRIC MOTORS; F. R. Bacon, Milwaukee, Wis. App. filed Dec. 21, 1896. In electric motor controlling mechanism the combination with a series of contacts, back-stops and electro-magnet of a rheostat, and a switch-lever pivotally connected to a pin on said rheostat, of a switch arm independently pivoted on said pin and adapted to be held against the core of said magnet when the latter is energized, and a spring connected to said switch-arm, so as to always draw said arm away from said magnet when the latter is de-energized, irrespective of the purpose of the switch-lever.

578,710. STORAGE BATTERY; C. T. Barrett, Brooklyn, N. Y. App. filed May 4, 1896. In a storage battery a cell, consisting of a plate of pumice stone, to which the peroxide or equivalent material is applied, in combination with a confining envelope of lead, having openings for the admission of the acidulated fluid.

578,716. TELEGRAPH FIRE HOSE; J. Buchtel, Portland, Oregon. App. filed April 4, 1896. In a telegraph fire hose, the combination of a hose-section adapted to be connected with the fire-engine or water-plug, and a series of sections, each carrying conductor-wires, one of such sections having a nozzle provided with a circuit-closer, of an independent pipe-section connecting the ordinary hose and the telegraph hose and carrying a signal apparatus, a cut-off valve, a relieve cock and a draw cock.

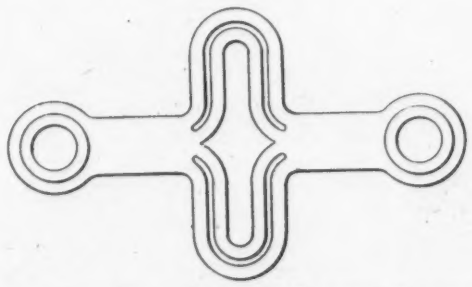
578,750. CIRCUIT BREAKER; H. P. Kelly, Philadelphia, Pa. App. filed April 7, 1896. In a circuit-breaker a breakable strip included in the circuit, and mechanical means controlled by the circuit for mechanically breaking the strip without previously fusing it.

578,771. CUT-OUT AND AGITATOR FOR DUST TRANSMITTERS FOR TELEPHONES; S. B. Rawson, Elyria, Ohio. App. filed June 14, 1895. In a telephone, the dust transmitter on a jointed arm, a battery wire connected to said arm and movable therewith, the bell connections having fingers in position to be engaged and thrown into circuit by said arm in one position, and the transmitter having a finger connected to the battery-circuit and in position to be engaged by the arm when in another position.

578,823. CHARGING SECONDARY BATTERIES; I. Kitsee, Philadelphia, Pa. App. filed Nov. 2, 1895. In combination a charging plant for secondary cells consisting of a circuit carrying a current of comparatively high electromotive force, a series of incandescent lamps of comparative small resistance placed in multiple arc as to the main circuit, but in series as to each other, and sets of secondary batteries placed each in multiple arc to one of said small-resistance lamps.

578,825. INSULATOR; H. H. Luscomb, Hartford, Conn., and W. F. D. Crane, Orange, N. J. App. filed Oct. 24, 1896. An insulator, consisting of a body provided with means for attachment to a support, and having arms that project upwardly from opposite sides of the body near the top, fingers loosely connected with and movable between the arms, a part of the fingers being adapted to support the wire and a part of the fingers being caused to embrace the wire by the action of the weight of the wire.

578,829. RAIL BOND FOR ELECTRIC RAILWAYS; T. J. McTighe, Brooklyn, N. Y., and S. W. Childs, of Natick, Mass. App. filed Oct. 9, 1896. A duplex rail-bonding device, consisting of two metallic



No. 578,829.—RAIL BOND FOR ELECTRIC RAILWAYS.

conductors, one on each side or face of the rail, and having inwardly projecting ends and means for drawing said ends into a single hole in the rail and securing them therein.

578,840. RAILWAY CROSSING SIGNAL; C. Selden, Baltimore, Md. App. filed Feb. 11, 1897. The combination with a railroad crossing signal adapted to be set from either side of the crossing, and provided with resetting devices for throwing it out of action at or about the time the train reaches the crossing, of a supplemental circuit and circuit-closer operated by the train for keeping the signal temporarily in action while the train is passing said signal.

578,853. ARRANGEMENT FOR CLOSING OR OPENING BARS AT RAILROAD CROSSINGS; H. Biermann, Breslau, Germany. App. filed April 6, 1896. An apparatus for automatically actuating a crossing-gate and sounding an alarm, comprising a rail in three insulated sections, an alarm connected to the outside sections and an electric motor controlling the gate connected to the central section.

578,867. ELECTRIC BATTERY; H. N. Farley, Warwick, N. Y. App. filed April 11, 1895. A system of operating a plurality of independent electrical instruments, consisting of a single battery cell having a single electro-negative element and a plurality of electro-positive elements, said electro-positive elements being grouped at spaced distances apart, and having no metallic contact within or exterior to the cell, a single conductor leading from the negative element and carrying a common connector, and a series of separate pairs of circuit-wires, one of the wires of each pair connecting with an electro-positive element of the cell and the other wire of the same pair connecting with said common connector.

578,870. ACTIVE MASS FOR ELECTRIC ACCUMULATORS; S. Hammacher, Berlin, Germany. App. filed June 27, 1895. An active mass for electric accumulators, consisting of basic phenylates of lead mixed with the oxides of lead.

578,887. PASTE FOR ELECTRIC ACCUMULATORS; R. Linde, Berlin, Germany. App. filed Feb. 24, 1896. In a filling-paste for electric accumulators the combination of the lead oxides with a bitter principle.

578,893. BURGLAR ALARM; M. P. McDermott, Auckland, New Zealand. App. filed Aug. 7, 1896. In combination, two batteries, an alarm, contacts to be closed by the unauthorized person, a magnet and the armature thereof, a line wire extending from one pole of the battery to the magnets, circuit-wires extending from the magnets to the contacts, and thence to the other pole of the battery, a contact and a wire leading therefrom to the first battery to maintain the circuit complete when the armature is attracted by the magnet upon the closing of the contacts, circuit wires leading from the second battery, said circuit including another contact, an armature and the alarms and a switch controlling the circuit of the battery whereby both circuits may be broken at one operation by de-energizing the magnets.

578,954. ELECTRICAL CONTROLLING APPARATUS; B. C. Van Emon, San Francisco, Cal. App. filed May 22, 1896. In electrical controlling devices, the combination of a main switch-lever placed in the elevator car or cage, contacts, double oscillating switches turning on a central axis, solenoids for closing said switches to the right or to the left, and springs adapted to return and hold said switches in a central or neutral position when they are open.

578,976. ELECTRIC CLOCK SETTING MECHANISM; C. M. Crook, Elgin, Ill. App. filed Jan. 11, 1897. In combination with the hands-train of a clock, an electro-magnet mounted on the clock-frame and a circuit in which the same is energized, an armature for said magnet and a lever connected thereto and actuated by the movement of the armature towards and from the magnet-poles, said lever having a pin or projection which, in said movement of the lever, is protruded through the plane of rotation of a wheel in said train, and moved laterally after such protrusion to encounter a spoke or web of said wheel and rotate the same.

578,981. LIGHTNING ARRESTER; W. K. Freeman, Fort Wayne, Ind. App. filed July 5, 1895. In a lightning arrester, the combination with a bracket or support, fixed electrode carried thereby and movable electrode having a magnetic pendulous end normally standing in proximity to but out of contact with the fixed electrode, of a curved electro-magnet located in proximity to and at one side of the fixed electrode, but out of the path of movement of the pendulous end of the movable electrode, whereby said movable electrode is permitted to have a free movement, said electro-magnet being connected in circuit through the air-gap between the electrodes.

578,984. TEMPERATURE CONTROLLING APPARATUS; S. Green, New York, N. Y. App. filed June 16, 1896. The combination, with a valve having resistance of movement in one direction, of an electric motor for actuating said valve, a rotary crank operated by the motor, and acting on a vibrating arm connected with said valve, so that a long radius of the arm is engaged in moving the valve against its resistance, and a short radius of the arm is engaged when the valve is moved in an opposite direction, an electric generator, a main circuit, a circuit-closer, and an electric switch operated by said motor, and electrically connected with the motor-operating circuit, whereby the said crank is arrested at a point intermediate to its range of travel on said vibrating arm.

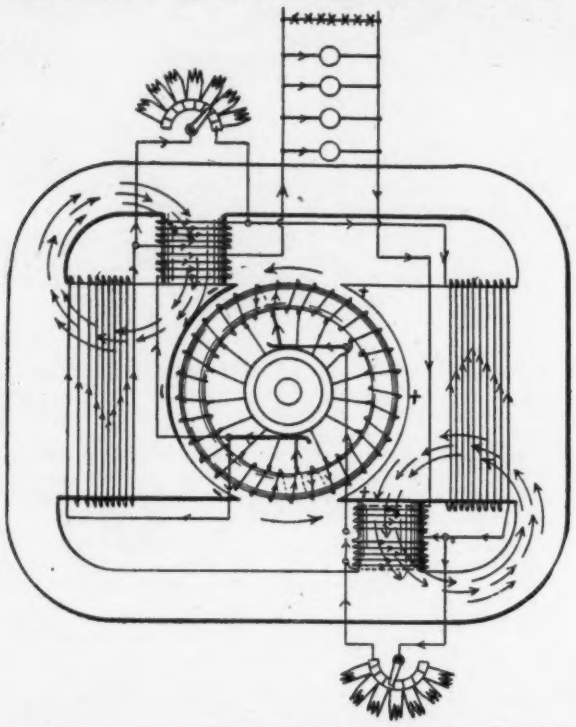
578,992. MULTIPLE TELEPHONE; S. W. Holman, Boston, Mass. App. filed May 31, 1893. In combination with two original metallic telephone-circuits, each consisting of two conductors and a telephone at each end of each, an added metallic telephone-circuit consisting at each end of a telephone, each terminal of which is connected in multiple with the two conductors of one original circuit through two wires wound equally about each portion of a magnetic core, in opposite directions regarding currents, which flow through the two windings in multiple.

578,997. REPEATER; C. W. Leiser, Carlinville, Ill. App. filed April 1, 1896. A telegraph-repeater, comprising two relays provided with armature-levers each having two spring-contacts, two stationary contact-points for each armature-lever, two batteries connected with the main lines and with the forward stationary contacts of the re-

lays, and the electrical connections, whereby signals made on one line will be repeated on the other line.

578,001. BATTERY; S. J. Martin, Detroit, Mich. App. filed May 27, 1896. In a secondary battery an electrode consisting of a series of perforated tubes attached to and surrounding a central core, said tubes adapted to contain the active material.

579,003. TELEPHONE TRANSMITTER; W. J. Moore, Elmer, Mich. App. filed May 25, 1896. In a telephone transmitter, the combination with a solid part having an annular funnel-shaped hole extending inwardly into the solid material, and having an annular hole intersecting said funnel-shaped hole and extending to a diaphragm, of a diaphragm resting on a ring of metal on a ledge of an annular



No. 579,059.—Construction and Regulation of Electric Machines.

enlargement of the intersecting hole, and the ring of metal, granular carbon on said diaphragm, solid carbon resting against the granular carbon, a cap covering and securing the diaphragm granular carbon and solid carbon to the solid part, a binding post on the cap connecting the said carbon to a source of electricity and means for electrically connecting the metal ring and means for pivoting the transmitters thus formed.

579,012. DYNAMO ELECTRIC MACHINE; G. A. Scheeffer, Peoria, Ill. App. filed April 30, 1892. In a dynamo electric machine of the inductor type, the combination of a single field magnet core parallel with and surrounding the shaft, a field magnet coil wound thereon, a single set of armature-cores parallel with the shaft and arranged in a single circle, coils on said cores, an extension magnetically connecting the field-magnet core with the armature cores, and a rotatable disk, with slots cut in its edge, extending from the end of the field-core to the ends of the armature-cores and completing the magnetic circuit.

579,024. ELECTRIC ELEVATOR; S. D. Strohm, Philadelphia, Pa. App. filed April 4, 1896. In an electric elevator, the combination of an elevator car or cage, an electric motor for operating the same, a switch controlling the circuit to said motor, a solenoid or magnet for operating said switch, a safety circuit, including said solenoid or magnet, and a closer or breaker in said safety-circuit controlled by a door opening on the elevator shaft.

579,028. CONTROLLER FOR DYNAMO ELECTRIC MACHINES; C. E. Woods, Chicago, Ill. App. filed Jan. 15, 1896. A controller for dynamo electric machines, comprising a rotatable shaft having a cylinder rigidly connected therewith, said cylinder provided with a series of separated contacts of brushes opposed to said contacts, an operating handle connected with said shaft, a movable part associated with said cylinder and connected with a brake associated with the dynamo electric machine, and a connection between said contact cylinder and the movable part associated therewith, whereby said cylinder is automatically moved to its normal open-circuit position when the brake is applied.

579,032. ELECTRIC ARC LAMP; T. E. Adams, Cleveland, Ohio. App. filed Oct. 1, 1896. In an electric arc lamp, the combination with the carbons and a clutch, of an electro-magnet having pole-pieces at both ends, one of said pole-pieces having an inclined extension, an L-shaped armature, connections between said armature and clutch, said armature having the extremity of its shortened arm pivotally connected to the shorter pole-piece of the magnet and adapted to be attracted thereby, and a longer arm of said armature having an end face to be attracted by said inclined polar extension, whereby to effect a long and steady pull on said armature.

579,036. TELEPHONE SWITCHBOARD PLUG; F. E. Bossong, Watseka, Ill. App. filed Sept. 16, 1896. A plug for telephone switchboards, comprising a non-conducting body portion, a conducting portion or head, a stationary contact, secured within said body portions and designed to be electrically connected with a subscriber, a secondary stationary contact secured therein, and designed to be electrically connected with a signaling-current generator, a movable contact connected to said conducting portion or head, and adapted to contact alternately with said stationary contacts, a second movable contact attached to the non-conducting body portion and adapted to be moved into contact with the conducting portion or head, said movable contact designed to be electrically connected with a central operator's telephone-set, and push-buttons for actuating said movable contacts.

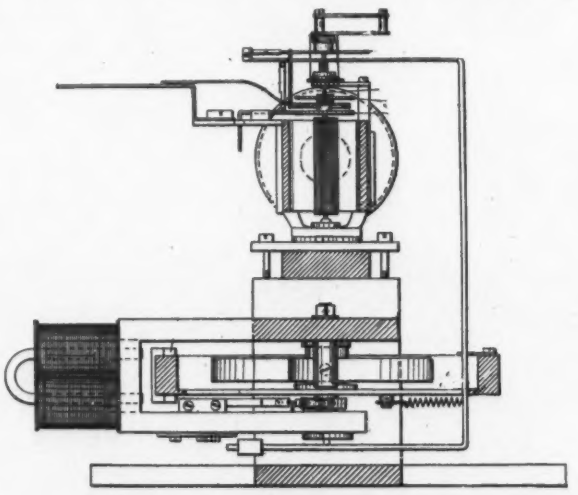
579,051. MEANS FOR PROTECTING ELECTRIC MACHINES FROM HEAT; J. P. B. Fiske, Alliance, Ohio. App. filed Jan. 12, 1895. The combination with an electric machine and a housing inclosing the same, the latter having openings in the ends, of a fan located in one of said openings, said fan being carried by the armature-shaft of the said electric machine.

579,059. CONSTRUCTION AND REGULATION OF ELECTRIC MACHINES; T. H. Hicks, Detroit, Mich. App. filed Feb. 23, 1895. In an electric machine provided with field magnets, each having polar lips, the combination therewith of a short-circuiting magnet magnetically joined to only one polar lip of each field magnet.

579,062. ELECTRIC MOTOR AND DYNAMO; W. S. Horry, Gloucester City, N. J. App. filed June 15, 1892. The combination of field magnets, wound so as to have a rotating field, a stationary commutator therefor, a rotating armature therefor, and a commutator secured to the rotating armature, rotating brushes for each of the commutators, whereby the poles in the field magnets are caused to be at an angle to the poles in the armature, a motor-circuit including the brushes for coupling the field in circuit with the armature, and power devices to revolve the brushes, whereby the poles of the field and the armature may be caused to revolve independently of the rotation of the armature and its shaft.

579,063. REGULATOR FOR ELECTRIC MOTORS; R. M. Hunter, Philadelphia, Pa. App. filed May 22, 1894. The combination of a line circuit, an electric-power motor in said circuit, and a variable counter-electromotive force generator interposed in the line circuit in shunt relation to the power-motor and generating a counter-electromotive force opposed to the initial electromotive force of the line circuit, consisting of a revolving armature, field-magnets for producing a field in the vicinity of the armature, and means for shifting the armature relative to the field, or vice versa, for producing a variation in the inductive relation between the armature and the field-magnets.

579,075. ELECTRIC CALL AND CALL ANSWERING APPARATUS; E. H. Owen, C. N. Williams and F. H. Donaldson, Garvanza, Cal. App. filed Sept. 14, 1896. The combination in an electric call and call-answering apparatus, of a case or holder, a plurality of electro-magnets secured therein, an armature pivoted in juxtaposition to the poles of each magnet, and provided with an attached sign or visual-signal device, which is moved in a circular path by the motion of the armature, a switchboard having a plurality of contact-pieces and a plurality of push-buttons electrically connected with said contact-pieces, a switch movable into engagement with



No. 579,079.—Electricity Meter.

any one of said contact-pieces, a call bell electrically connected with the switch, an electric generator, an electric circuit, including the electro-magnets, the switch, the contact-pieces, the push-buttons and the call bell, and a device remote from the signs or visual-signal devices, and switchboard for making and breaking the circuit independently of said push-buttons.

579,079. ELECTRICITY METER; A. Raps, Berlin, Germany. App. filed July 25, 1896. An improved electricity meter, consisting of a suitable direct-reading electrical measuring instrument, an oscillating balance and a registering wheel, all said parts being concentrically pivoted, means for registering the revolutions of said wheel and means for coupling the said balance with the said wheel at every oscillation at the point indicated by the deflection of the needle of the measuring instrument.